

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 145 BROADWAY, NEW YORK.

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Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid.....\$3 00
Subscription, per annum, Foreign Countries..... 3 50
Single copies..... 25
Remittances should be made by Express Money-Order, Draft, P. O.
Money-Order or Registered Letter.

NEW YORK, JULY, 1890.

THE latest Rapid Transit Commission in New York appointed under the old law, has ended its labors by a simple recommendation for an underground line extending from City Hall to the Grand Central Station in Forty-second Street, following the line of existing streets, with two short cuts through private property. This is hardly a solution to the problem, since a line to Forty-second Street only would be of very little account in improving the present means of transit; but it may be useful if an arrangement can be made for working it in connection with the tracks of the New York Central & Hudson River Railroad north of the Grand Central. Possibly it is the best that the Commission could do, since its action was so limited by certain provisions of law that a better result could hardly be expected. As the matter stands now, it is very probable that the work of the Commission and its recommendations will practically result in nothing.

THE sharp competition between the Pennsylvania Railroad and the Baltimore & Ohio has led to the reduction of the time of the fastest trains between New York and Washington to about five hours on both lines. For a distance of about 225 miles, with considerable deductions to be made for the ferry at New York, grade crossing stops, the passage through Philadelphia and Baltimore, it will be seen that this time requires running faster than has yet been seen in America for regular trains, and indeed a speed which is not exceeded anywhere.

THE acquisition of the St. Louis & San Francisco lines by the Atchison, Topeka & Santa Fé Company is another step in the process of railroad consolidation which is constantly going on. The Atchison Company now claims the largest system, since it controls very nearly 9,000 miles of road, or about one twenty-fifth part of the total mileage of the United States.

The transfer is a natural one, as the two companies had many joint interests and their lines are so connected that any hostility or even serious difference between the two managements would have made much trouble for both.

It has been made by the purchase of the St. Louis & San Francisco stock by the Atchison Company, in exchange for its own issues.

THE narrow gauge is gradually but steadily disappearing. The latest railroad to abandon it is the Anniston & Atlantic, a line 53 miles long in Alabama, which has just completed its change from 3 ft. to standard gauge.

The longest narrow-gauge line in this country—the Denver & Rio Grande—is making steady progress with its change to standard gauge, and will before long entirely abandon the 3 ft. gauge.

IRON production, which has been very large all the year, continues to increase. The report of the *American Manufacturer* shows that on June 1 there were 340 furnaces in blast with a weekly capacity of 181,953 tons, which is a decrease of one furnace, it is true, but an increase of 1,000 tons in the weekly production, during the month of May. Quite a number of changes were made in the list during the month, but with the general tendency to increase rather than diminish production, the furnaces which have gone out of blast having stopped mainly for repairs or other necessary causes, while their places have been more than filled by those which have gone into blast. It seems probable that the pig-iron production for the year will show a considerable gain even over the large figures of last year.

IN consequence of the illness of Professor Jameson, we are compelled to omit this month the usual installment of the articles on the Use of Wood in Railroad Structures. Their publication will be continued, however, in the next number, when several plates will be given with the usual description.

ENGLISH AND AMERICAN LOCOMOTIVES.

LAST winter a number of the locomotive builders in this country received an invitation, through the Engineering Committee of the Edinburgh International Exhibition, to send a representative express locomotive to be exhibited there, and have it subjected to a competitive trial with a similar engine built on the other side. This invitation was declined. In commenting on this a short time ago, the *Engineer*, unfortunately and unwittingly referred to our national emblem as the "stars and bars." This excited the patriotic wrath of our contemporary, *Engineering News*, and on February 8 the Editor of that paper replied with a good deal of acerbity, and wound up by conceding that "in hauling light trains at high speed over the most costly and perfect track, with moderate consumption of coal, an American locomotive might not do quite so well as an English one." But, the writer in that paper says further, "when it comes to hauling very heavy trains, especially maximum trains, at slower speeds, or to coal consumption per ton mile or passenger mile, or to cost of repairs for equal loads, or long mileage per year and between repairs, or to service on slightly inferior track—here, we think, the English locomotive would compare to poor advantage."

The editor of the *Engineer* then apologizes for calling the stripes of our flag "bars," thanks our contemporary for the admission that in hauling light trains at high speeds they can probably beat American engines, and for its side "admits" that in engines with eight, ten or twelve

wheels coupled English engines "make no show," but this, it is said, is simply because they do not want to make a show. The *Engineer* goes on to say that "there is a certain proportion of goods hauling done in the United States with engines of much the same general dimensions as those used in this country, and it is quite possible to institute a comparison between these two types." Our foreign contemporary then invited his American brother to give a definite statement of the advantages possessed by the American locomotive over the English, and "explain precisely in what way and how the American engine is a better all-round machine than ours;" and it says further that, "we would ask our contemporary, to begin with, to confine his attention to one feature at a time, and we suggest that it should take boilers first, and the whole practice of making steam and the method of firing with bituminous or semi-bituminous coal, comparing English and American methods together, pointing out the defects of the former and the advantages of the latter."

In its issue of March 15 the *News* accepts the *Engineer's* apology for disrespectful mention of the stripes in our flag as "bars," and also its challenge to show that the American locomotive is a better all-around machine than its English cousin. But, the Editor of our American contemporary adds, we will allow "ourselves" some little time before doing so. The decks, therefore, have been cleared for action, but up to the date at which this is written the cis-Atlantic adversary has not fired a gun.

The issue, it will be seen, is narrowed "considerably," it is "allowed," by the one party in the contest that "in hauling light trains at high speeds they (the English engines) can probably beat ours." On the other hand, the British adversary admits that in engines with eight, ten or twelve wheels coupled, "they make no show." In this he is like Dickens's character, whose room was disparaged because it was not big enough to "swing a cat in," and who vindicated it by saying that he "didn't want to swing a cat." So the *Engineer* says, in what he calls "caterpillar engines" they "don't want to make a show."

The issue, then, seems to be narrowed down to the challenge of the *Engineer* to "explain precisely in what way and how the American engine is a better all-round machine than ours."

As remarked before, up to the date of writing our New York contemporary has remained silent. In the meanwhile, the *Railroad Gazette*, probably, as the other party to the contest remarks, tired of waiting, has come forward to defend the American locomotive against all comers, and the first of two articles appeared in its issue of April 25. The first half of this article is devoted to showing the impossibility of making a comparison of either the performance or economy in cost of repairs of engines working in different countries under diverse conditions; and it says, "On foreign roads, for which both English and American designers have been called upon to supply engines such comparisons are possible." The *Gazette* intimates that the fact that American engines have been largely sold to such countries is proof of their superiority, and that they, long ago, ran English locomotives out of Canada is conclusive as to the merits of the former.

To the first argument the *Engineer* replies that the reason why "American locomotives have in certain cases been bought for our colonies, instead of English engines, . . . results . . . from causes which possess no scientific interest," and refuses to discuss them. It must be admitted that

the *Gazette's* argument, or rather its citation of facts, is a little tottering. If a medicine maker should advertise that a sick man had taken his Patent Panacea, and had been much benefited thereby, but at the same time it should appear that the convalescent had also swallowed an equal or a greater quantity of the Universal Remedy, it might be a question whether the Panacea or the Remedy cured the patient. The Canadian argument is better, and it remains for our foreign contemporary to explain why on Canadian roads which were first equipped with English locomotives they have been displaced entirely by those of American design.

The *Engineer*, however, pulls itself together here, and counters with the remark that "neither the *Gazette* nor any other American authority will condescend to say specifically in what the fitness (of American locomotives) consists that has led to their survival." Our British contemporary had not yet heard from *Engineering News* when it wrote those brave words. The *Engineer* shouts vehemently, "Our locomotives burn less coal than yours do." The *Gazette* answers, "What if they do; we pull more than you can." From across the Atlantic comes the interrogation to us, "What do your locomotives cost for repairs, anyway?" and the *Gazette* answers ruefully, "We don't know, but we intend to know;" and with real Yankee interrogative retaliation asks, "What do yours cost?" and their adversary replies, "We don't know either;" and they then proceed to write long arguments based on what they don't know.

The *Gazette* then "goes in" again and says, "You admitted, on March 14, that your stationary steam engines were defective in workmanship, which shows that your locomotives are 'no good.'" This, the *Engineer* says, is not fair, and that in the article referred to they did not mean locomotives, but stationary engines; that when the Webb engine arrived at Altoona all the leading officials in the locomotive department were sent for, that "they might see what really first-class work was like." In a "critical" article published in the issue of February 28 the *Gazette*, unfortunately for its side of the discussion, "frankly told the defects of some American locomotives," and, as its opponent asserts, "said more hard things of American practice than we ever dared to say." Admissions like these often rise up before us like ghosts and then become

"As the air, invulnerable
And our vain blows, malicious mockery."

In this instance another ghost, in the form of a sample English locomotive sent to the Western Railway of France, which, it is said, had to be nearly rebuilt after running a short time, was called up by the *Gazette* to lay the specters that were let loose on February 28.

In its second article, the *Gazette* mentions the valves on the inside of cylinders, crank-axes, lack of facility in oiling, absence of means of adjustment of driving-boxes, as defects in English engines. The reply made to these charges is that the *Gazette* "asserted that the exhaust in this country is very much throttled in inside cylinders, and yet he states in another place that English engines are free from the hindrance of a throttled exhaust, to which American engines have to submit to blow their fires." As the American editor knows little about crank-axes, it is said that "it would be perhaps too much to expect a valuable expression of opinion." If our contemporary had referred to the Returns of Accidents by the British Board of Trade, they would have learned there that in 1885 190 crank or

driving axles were broken in the United Kingdom, 210 in 1886, 145 in 1887 and 112 in 1889.* The other defects of English engines which have been enumerated by the *Gazette* are passed over by the *Engineer* with derision. But our foreign contemporary has not, it is to be feared, measured its other, thus far silent, foe. The quiescence of *Engineering News* since last March has probably not been purposeless, and may be portentous.

The discussion recalls a venerable story of what occurred down in Kentucky on a certain election-day, when the arguments employed were forcible but not convincing. After the event the participants were brought up in court to answer for their indiscretions, and a certain Jim Bludsoe testified that while the fight was going on he and his friend Sassy Hammet was "a-sloshin' round." The judge asked him to explain. "Well," he says, "you see, Hank Smith, he was a-holden Country Jake down with his nose between his teeth, and that feller what keeps the tavern had young Millican's head under his arm, and was doin' his best to improve his looks, and Sassy and me was sloshin' round." But the court asked, "What do you mean by 'sloshin' round'?" "Well, you see, jedge, there was a pile of fellers in the middle of the fight, which was piled up about six deep, and they was a-scratchen and a-buttin and a-biten and a-hitten each other, and we was a-sloshin' round—that is, wherever we seed a head that was loose we hit it." Now, after *Engineering News* opens its guns, if Edward Bates Dorsey would only step in and take a part in this delightful controversy and begin "sloshin' round," the entertainment will become complete. The *Engineer* will wish it had never been born, the American locomotive will distend its nostrils, and declare itself victorious with a shriek which will be heard from Alaska to Patagonia, and will penetrate either diametrically through the earth or be wafted circumferentially around it to our antipodes, who, standing on their heads, may be able to comprehend the significance of the arguments.

THE CAR BUILDERS' AND MASTER MECHANICS' CONVENTIONS.

THE attendance at the two meetings just held at Fort Monroe was larger than it has been any year heretofore, and the interest in them showed no signs of abatement. There was, however, a general demand from those in attendance that some arrangement should be made for holding the conventions so that less time will be consumed in attending them both. Those persons having charge of both the car and locomotive departments, who are interested in the proceedings of both Associations complain—and with good reason—that they cannot give two entire weeks to these meetings. As a consequence of this outcry each Association has appointed a Committee of conference to make some mutual arrangement, if it is possible to do so, for holding the two meetings, so as to occupy less time than they do now. At present one of the Associations holds its first session on Tuesday and its meetings generally continue through Wednesday and Thursday, the final adjournment occurring on Thursday afternoon. There is then an interval of Friday, Saturday, Sunday, and Monday, until the following Tuesday, when the first meeting of the

other Association is held. This interval is long and tedious to those who remain for both conventions. It was therefore proposed that the first session of one of the Associations should be held on Wednesday, and the following ones on Thursday and Friday, and that the meetings of the other body should meet on Monday and occupy that day and Tuesday and Wednesday. This would reduce the time two days. There are, however, some objections to this plan. There would still be an interval of two days between the meetings, and the time occupied from the opening of the one convention to the close of the other would be *eight* days instead of *ten*, as at present. Past experience has shown, too, that it is almost impossible to get a good attendance of members at a meeting held on Monday. Those who must come any considerable distances have a disinclination to start from home on Sunday morning, and they assume—as is partly true—that the opening session will be less interesting than the succeeding ones, and they arrange to arrive at the place of holding the meeting on Tuesday morning.

Besides these objections, the plan proposed will still consume most of the time of two whole weeks.

Another plan which has been suggested is that one of the Associations should hold its first session on a Monday evening. Most of the members could then reach the place of meeting by leaving home on Sunday night, or those near to it could do so by starting Monday morning. The opening exercises could be held, the President's address heard, the reports of officers received, and other routine business transacted. It is not of great importance whether the attendance at these proceedings is very large or not, but they always consume a great deal of time, and if they were disposed of during a preliminary evening meeting it would leave the table clear at the following session on Tuesday morning. The whole of Tuesday and Wednesday, without any routine business, would in most cases be sufficient for the ordinary proceedings of either convention. The other Association could then hold its first meeting on Wednesday evening, and have Thursday and Friday clear for its other sessions. The two meetings would thus occupy *four* days' time instead of *ten*, as at present, or *eight*, as would be required by the other proposed arrangement.

As some sort of excursions and entertainments seem to be inseparable from these occasions, the four-day plan would permit the members of the one body to amuse themselves during two days while those of the other are in session. If for any reason the organization which meets first could not complete its business in the time allotted to its meetings, there is nothing to prevent it from continuing its sessions after the other meets—in other words, the Associations could hold meetings simultaneously if there was occasion for doing so.

The only difficulty to be anticipated would be a lack of adequate hotel accommodations if both organizations held their meetings so near together. This could be provided for by judiciously selecting places where the hotels are large enough.

COLD WATER WITHOUT ICE.

THE following method of obtaining a constant supply of cool water at all times is in general use in Hanover, York County, Pa. The town is built over a stratum of limestone, so that the water is "hard," or impregnated with lime. The town is also closely built up and without any system of drainage, so that the water from the wells is unfit to

* The reports unfortunately do not say what proportion of those broken were crank-axes and how many were straight, but, owing to the large proportion of inside cylinder engines in use on British roads, the larger proportion of those broken are doubtless crank-axes. Our report for 1888 is unfortunately missing.

drink. Some years ago these reasons led to the introduction into the town of a supply of very excellent water from a large spring about three miles distant. This water is brought through iron pipes, and when it reaches the consumer in summer is warm, while the water in the wells is cool. For this reason many of the inhabitants drink the well water, and as a consequence typhoid fever is a prevalent disease in that community. In order to obtain pure cool water, not impregnated with lime, some of the inhabitants of the place have adopted a plan which is so simple and gives such excellent results that it is worthy of general adoption wherever there is a water supply other than wells or springs. The plan is as follows: a cylindrical galvanized sheet-iron tank, 12 in. in diameter and 4 ft. or 5 ft. long, is placed in the bottom of a well. This tank is then connected by a galvanized iron pipe with the water supply pipes, and another pipe is carried from the tank to the surface of the ground or to any convenient point for drawing water, and has a cock at the upper end. The tank is consequently always filled with water from the water supply, and being in the bottom of the well, the water is cooled off and acquires the temperature of the well; so that that which is drawn from the tank is as cool as well water, and is without any of the impurities with which the latter is contaminated. The water drawn from the tank in one of the wells in the place named had a temperature of 56° when the thermometer in the atmosphere above stood at 76°.

This method gives an abundant supply of cool water during the whole summer, and can be adopted in all cities, towns or in the country. If a well is available, it can be used; if not, by simply digging a hole in the ground, deep enough so as not to be affected by the surface temperature, and burying the tank, it will answer equally well. This hole might be dug in a cellar or outside the building. If the water has any impurities in suspension, such as mud, the tank should be made accessible so that it can be cleaned occasionally. It is a common practice in cities for people who cannot afford ice in warm weather to use water from wells which are little used at other times. The water in these wells is nearly always contaminated with dangerous impurities. If a tank was placed in them and arranged as described it would give a supply of cool and pure water. Water from cisterns, if above the surface of the ground, can be cooled in the same way.

SMOKE PREVENTION.

THIS subject, like poverty and taxes, we have always with us. In the cities west of the Allegheny Mountains, where bituminous coal alone is burned, it is becoming of growing importance, and even in New York many tall chimneys now throw out black clouds, showing that the use of the same fuel is becoming common there. In England the subject has attracted most attention, and for many years past has been legislated about and investigated until the subject has been darkened by the magnitude and extent of the efforts to throw light on it.

The English technical papers tell us that a well-attended public meeting, convened by the Lord Mayor of London, was recently held to promote the work undertaken by a committee for testing smoke-preventing appliances.

The perplexing feature of the whole subject is that for fifty years or longer English and American engineers have been doing their best to prevent smoke *economically*. It

can be and has been prevented, but the difficulty is that it costs more than it is worth. At this meeting the Mayor of Rochdale said:

He did not find it so easy to consume smoke as Mr. Hart had said; in fact, after trying for 40 years, he had not yet succeeded. There were firms in Rochdale who, having spent hundreds of pounds in endeavoring to consume their own smoke, were now taking out their smoke-consuming appliances, because they did not succeed.

Another speaker expressed the opinion that perfection had not yet been reached in the matter; and a third said:

What was wanted was not new experiments or new tests, but the adoption of existing resources, which it had been conclusively proved were sufficient to prevent smoke in any manufactory of any kind or size.

The Earl of Derby, after some very interesting remarks, said:

Since this meeting was called I had a visit from a tenant on my own estate, renting collieries from me, and he declared that for 13 years he has worked on the principle of suppressing smoke entirely, that he has found it practicable, and more than that, that he has made it pay.

Now, if the latter statements are true, if some of the English engineering papers would describe fully the "existing resources," which one speaker says "it had been conclusively proved are sufficient to prevent smoke," and the method in use by the Earl of Derby's tenant, such descriptions would be of very great interest to the much smoked inhabitants of some of our Western cities, and doubtless to many of the same class of people in England.

NEW PUBLICATIONS.

PAVEMENTS AND ROADS: THEIR CONSTRUCTION AND MAINTENANCE. REPRINTED FROM THE *Engineering and Building Record*: COMPILED BY E. G. LOVE, PH.D. New York; published by the *Engineering and Building Record*, No. 277 Pearl Street (price, \$5).

This book is a compilation of articles on the subject which have appeared in the *Engineering and Building Record*; these articles have been edited with a view of eliminating such matter as might be only of local or temporary interest.

The book is divided into three parts. Part I treats of street pavements, containing chapters on Stone Pavements; Wood Pavements; Asphalt Pavements; Brick Pavements; Curbs, Sidewalks and Tramways; Street Opening and Maintenance, and Notes of Experience. Part II treats of the Construction and Maintenance of Roads, and Part III contains the prize essays on the same subject which were submitted in a competition instituted by the *Record*.

The book contains a large amount of valuable information collected from various sources, including records of experience with pavements of various kinds, methods of construction and maintenance adopted in this country and in Europe, and other matter of a similar kind; most of it practical and easy of application. It is on a subject upon which information is much needed, and which has been too generally neglected in this country, and the book is therefore likely to be of much service to engineers. Of course, a great part of the information was already in existence, but not in a shape to be readily accessible to those who needed it; and it is also a fact that this treatise is the first American work on the subject which has appeared in a considerable time.

Among the chapters claiming especial note are those on Asphalt Pavements; on Brick Pavements, and on Curbs, Sidewalks and Tramways. The specifications given for asphalt will be found worth noting, as will also those for wood paving and for paving materials.

The book contains 410 pages, and is published in good shape, though a little more liberality in the matter of illustrations might

be desired. It is well worth a careful reading by all who are interested in the subject.

BANKERS' AND BROKERS' REFERENCE BOOK: BY ALFRED SMITH. New York; the American News Company.

In this book Mr. Smith presents, by figures only, a variety of useful information for those engaged in finance, speculation and investment. The only letter-press is a brief review of the general course of the New York stock market from 1877 to date, and some notes appended to the tables. The form of the book is convenient for the desk or the pocket, it is well and clearly printed, and cannot fail to be useful to those for whom it is designed. The Editor announces that by addressing him, care of the American News Company, special arrangements can be made by brokers and others, by which the book will be furnished in quantities with the name of the house wishing to use it for customers or for advertising.

MACHINED CAR WHEELS. Issued by the New York Car Wheel Works, Buffalo, N. Y.

In describing the current trade catalogues, one finds that the supply of adjectives for describing their luxurious character fail to be equal to the demand. We have before us a pamphlet of 30 pages printed on plate paper in the handsomest style of the printer's art. The cover is of heavy white coarse-grained paper, which looks like that made by Whatman for water-color drawing. It is to be feared, though, that its beauty is quite too delicate to be preserved in many of the places for which it is intended.

The matter of the pamphlet describes the evolution, use and merits of "Machined" Car Wheels as made by its publishers in their works in Buffalo. It describes the methods and processes by which cast-iron chilled wheels, which are ground so as to be perfectly true on their treads, can be furnished at prices very little, if any, above those of a first quality of unfinished wheels; how the character of the work has improved, and the advantages resulting from this perfection; and is an illustration of how railroad appliances are gradually being perfected. Every railroad manager, but especially car-builders, should read it.

BOOKS RECEIVED.

HANDBOOK OF PASSENGER TRAFFIC AND ACCOUNTS: BY MARSHALL M. KIRKMAN. Chicago; published by the Author. This book is received too late for proper comment in this issue.

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution. The present installment of these valuable papers includes Recent Dock Extensions at Liverpool, by George F. Lyster, with abstract of the discussion on the paper; Bars at the Mouths of Tidal Estuaries, by James Forrest, also with abstract of discussion; Abstract of Papers in Foreign Transactions and Periodicals.

THE MICHIGAN ENGINEERS' ANNUAL: PROCEEDINGS OF THE MICHIGAN ENGINEERING SOCIETY FOR 1890. Published for the Society; F. Hodgman, Secretary, Climax, Mich.

QUARTERLY REPORT OF THE CHIEF OF THE BUREAU OF STATISTICS, TREASURY DEPARTMENT, RELATIVE TO THE IMPORTS, EXPORTS, IMMIGRATION AND NAVIGATION OF THE UNITED STATES FOR THE THREE MONTHS ENDING DECEMBER 31, 1889. Washington; Government Printing Office.

CORNELL UNIVERSITY, COLLEGE OF AGRICULTURE, BULLETIN OF THE AGRICULTURAL EXPERIMENT STATION: XVII, MAY, 1890. Ithaca, N. Y.; published by the University.

SEATON MANUFACTURING COMPANY: ILLUSTRATED CATALOGUE OF BOLT-HEADERS, RIVET MACHINES, UPSETTERS, ETC. Cleveland, O.; issued by the Company.

THE WENSTROM DYNAMO AND MOTOR: ILLUSTRATED PROSPECTUS AND DESCRIPTION. Philadelphia; Chadbourne, Hazelton & Company, General Agents.

ILLUSTRATED CATALOGUE OF THE PRODUCTIONS OF THE JOSEPH DIXON CRUCIBLE COMPANY: GRAPHITE, PLUMBAGO, BLACK LEAD, PENCILS, CRUCIBLES, STOVE-POLISH, LUBRICANTS. Jersey City, N. J.; issued by the Company.

PORTLAND CEMENT FOR ENGINEERING WORKS: BY W. W. MACLAY, C.E. New York; issued by James Brand, Importer of Cements.

ABOUT BOOKS AND PERIODICALS.

IN the POPULAR SCIENCE MONTHLY for June Professor Henderson continues his interesting articles on Glass Making. M. de St. Pol Lias has an illustrated article on Tin Mining in Malacca, while Professor Griffin writes of Natural and Artificial Cements. Mr. Barr Ferree has an article on Utility in Architecture, in which the tendency to subordinate use and engineering to outside appearances is strongly criticised.

IN OUTING for June the military article is on the National Guard of Vermont. As if suitable to the opening season, there are several articles on Yachting, with the usual variety on other out-door sports.

The May number of the JOURNAL of the American Society of Naval Engineers is a very practical one, as can be seen from the titles of the leading articles, which are: Notes on Modern Boiler Shop Practice, by Past Assistant Engineer A. C. Engard; Boiler Shop of the Union Iron Works, San Francisco, by Assistant Engineer W. Stuart Smith; Notes of the Effect of Temperature on Certain Properties of Various Metals and Alloys, by Assistant Engineer B. C. Bryan; Machinery of the Torpedo-boat *Cushing*, by Past Assistant Engineer Stacy Potts; Tubulous Boilers, by Assistant Engineer S. H. Leonard.

Among the many interesting articles in SCRIBNER'S MAGAZINE for June one of the best is that on the Rights of the Citizen as a User of Public Conveyances, which is by President Seth Low, of Columbia College, New York. Mr. Low makes a strong argument in favor of the municipal control of franchises for public conveyance and city traffic.

The JOURNAL of the New England Water Works Association for June contains several valuable papers, while the report of the discussions contains a number of interesting records of experience.

The article on the Caucasus in HARPER'S MAGAZINE for June gives some account of the oil wells of Baku, which are important factors in the petroleum markets of the world. Mr. Park Benjamin gives an account of the working of Lieutenant Fiske's Range-finder, a very remarkable instrument. In the Best Governed City in the World there is an account of a business-like solution of some troublesome problems in municipal government.

The first number of SCIENTIÆ BACCALAUREUS is a very creditable one; it is a "Quarterly Journal of Scientific Research," published under the auspices of the Missouri School of Mines at Rolla, and edited by the Senior Classmen of that institution. This number has articles on the Transition Curve and on Continuous Construction of the Ellipse, by Professor W. H. Echols; on the Beginnings of Mathematics, by Professor W. B. Richards; on Tallow Clays, by Professor W. H. Seamon; and on the Establishment of the True Meridian, by George R. Dean. There are also a number of problems given for solution.

In the ARENA for June, while there is no article of special technical interest to engineers, there is abundant discussion of social and ethical questions which ought to be interesting to every intelligent man.

A CAUSE OF BOILER EXPLOSIONS.

To the Editor of the Railroad and Engineering Journal:

THE experiments of F. G. Fowler, mentioned in his paper, "A Cause of Boiler Explosions," an abstract of which appears in your May number, are of the most interesting and valuable character, as they bear directly upon a class of explosions the cause of which has been largely conjecture.

Although his experiments have been in the right direction, the results and observations do not seem to bear out the theory which he advances.

Professor Tyndall, in his work, "Heat a Mode of Motion," pp. 155-58, gives a clew to the conditions leading up to these mysterious explosions, and in the light of what is there stated, let us examine and interpret Mr. Fowler's experiments.

1. In the first place, Mr. Fowler lays all the blame to the "aerated" water. It would seem rather that the rupture of "set" of the "de-aerated" water lies at the bottom of all the difficulty; for, applying heat to his small closed boiler, filled with "aerated" water and air, would liberate all the occluded air and gases from the water and lock its molecules firmly together; and it can in this condition, without increasing the steam pressure, absorb a large quantity of heat, which becomes latent. Now reverse the boiler. The tension or set of the water is relieved by absorbing the air and gases mixed with the steam, which releases the latent heat, forming steam, and suddenly increases the pressure, as shown by the experiment.

2. No increase of pressure was shown to take place when the water is "de-aerated" and relieved of the presence of air and gases. And let us see why.

A greater amount of heat is necessary to attain a given steam pressure in a boiler containing de-aerated water than is the case with aerated water, for the reason, as shown, a large quantity of heat is absorbed by the water with tightly locked molecules and held latent. Any agitation or reversing of the boiler cannot alter the condition, as nothing is present to release the tension of the latent heat. If, however, the tension be relieved by opening a valve, there should be noted an increase of pressure, as shown in the first experiment. The latter condition is analogous to that of opening the throttle valve and rapidly drawing steam from a boiler which had been for some time entirely closed.

These conclusions would also seem to be borne out by the points used in corroboration of the theory advanced by Mr. Fowler.

The prevention of explosions from this cause, then, might be accomplished by opening the blow-off valve for a few moments as soon as the steam gauge shows 15 or 20 lbs., as that will destroy the set to the water before a dangerous pressure is reached.

Mr. Fowler, fortunately, has had the facilities for making his experiments in a practical way, and not found it necessary to rely on conclusions drawn in a more or less indirect way from physics. However, he might do well to continue his researches on the lines suggested by the experiments of Professor Tyndall, and disprove, at least, their relation to the class of phenomena which he has undertaken to explain.

K.

MASTER MECHANICS' ASSOCIATION REPORTS.

AT the Annual Convention of the Master Mechanics' Association a number of reports were presented by committees, all of them containing much information. The Committee on Axles for Heavy Tenders reported in favor of adopting the M. C. B. standard axle for cars of 60,000 lbs. capacity as the standard for heavy tenders.

The Committee on the Relative Value of Steel and Iron Axles—Messrs. John Mackenzie, J. S. Graham and John S. Cook—presented a large amount of information collected, but reported no definite conclusion, and recommended a further continuation of the subject.

The Committee on Brick Arches in Fire-boxes presented a report, the conclusions of which are thus summed up:

"In conclusion, your Committee find that the brick arch greatly assists in bringing about more perfect combustion, and thus aids in lessening the amount of black smoke formed, and, for the reasons already set forth, helps to con-

sume or rather burn out the combustible parts of the gases composing the smoke that is formed, and failing to find that any serious damage results from their use, and that the first cost and cost of maintenance, as compared with ordinary diamond stack, plain fire-box and short front, is plainly in favor of the former. We therefore recommend its use by all who desire to get the best and most economical results from bituminous coal fuel.

"We recommend as the best manner of supporting the arch that arrangement embodying as its principal features—First, freedom from any danger to those constantly employed about the engine by failure of parts, such as are sometimes attended by the use of circulating pipes. Second, one that can be quickly and cheaply, yet substantially put up and maintained, and that is in a measure protected by the arch from the action of the fire. Third, one that will allow the bricks to be removed and replaced with greatest ease and least possible damage, and that will give easy access to the boiler tubes, tube sheet and crown sheet when bricks are removed, and we think that these several conditions are nearer met by some of the methods shown on blue prints on exhibition in the meeting room, and known as the 'Angle iron and stud supports,' and we believe that the best features of some of these might be combined and worked into a support that will meet the requirements of the general service. We are not prepared to recommend the abolition of the circulating pipe, but we suggest the serious consideration of a safer and cheaper method for supporting brick arches than is obtained by their use.

"Before closing this report we desire to call attention to the large number of arch bricks broken in transit and by handling after they are received. This is especially the case where bricks are hauled long distances and when shapes are flat, long and heavy. It has occurred to us that some suitable means might be adopted to strengthen the brick by having iron rods made up in the moulds in such manner that should the bricks become cracked or broken through their section, they would be held together and could be utilized, and as soon as exposed to heat in furnace, they would fuse together from the effect of accumulated slag, etc."

The Committee on Corrosion of Water Tanks reported the results of inquiries recommending the use of good metallic paint, the sloping of the top sheets of the tank in order to prevent standing of water upon them, and the care and attention of the man running the engine. These, they think, would much prolong the life of the tank.

The Committee on Placing Fire-boxes above frames report substantially in favor of the wide fire-box placed above the frame, presenting a number of plans and suggesting some improvements in boiler construction, and also suggesting that the subject be continued for another year, in view of the fact that a large number of locomotives with fire-boxes above the frame are now being put in use or will shortly be, and that it will be desirable to collect the experience obtained with these.

The Committee on the Efficiency of the Link as Compared with other Valve Motions—Messrs. James M. Boon, David Clarke, H. Tandy and John A. Coleman—presented a report containing references to the Morton gear, the Joy gear, the Walschaert gear, the Stevens valve motion, the Wolfe gear, and to several others which have been tried in past years. The committee regret having no report of the performance of the Strong valve gear. While admitting the deficiencies of the link motion, they claim for it the advantages of standing rough usage. Their conclusion is summed up in effect in the following paragraphs:

"It frequently happens that the poor results obtained from a locomotive are charged to the valve motion, when the cause may be found in contracted steam passage pipes, leaky valves or pistons, steam wire drawn through the throttle, and back pressure, caused by contracted exhaust nozzles. It is surprising what a change will be made in the back pressure line of an indicator card by slightly increasing or diminishing the opening in the exhaust nozzle.

"In conclusion, your Committee are of the opinion that there has not been brought to their notice a valve motion more efficient for all-around work and general utility than a well-designed link with large bearing surfaces—assisted

in its work by steam passages and pipes of generous dimensions—free from sharp turns and bends—giving the link plenty and hot steam to distribute, and, most important of all, not crippled at the very end by a contracted exhaust nozzle."

COMPOUND LOCOMOTIVES.

The Committee on Compound Locomotives—Messrs. J. Davis Barnett, John Player, H. D. Garrett and F. W. Dean—presented a report, the substance of which is given below. The subject is divided by the Committee into several heads:

I. *Is compounding of any value without increase of boiler pressure?*

On this point the Committee is inclined to believe that a considerable gain may be effected by compounding at the present usual working pressures; at the same time believing that there are wide possibilities with increased pressures and temperatures.

II. *What gains have followed compounding?*

1. It has achieved a saving in the fuel burnt averaging 18 per cent. at reasonable boiler pressures, with encouraging possibilities of further improvement in pressure and in fuel and water economy.
2. It has lessened the amount of water (dead weight) to be hauled, so that
3. The tender and its load are materially reduced in weight.
4. It has increased the possibilities of speed far beyond 60 miles per hour, without unduly straining the motion, frames, axles, or axle boxes of the engine.
5. It has increased the haulage power at full speed, or, in other words, has increased the continuous H. P. developed per given weight of engine and boiler.
6. In some classes it has increased the starting power.
7. It has materially lessened the slide-valve friction per H. P. developed.
8. It has equalized or distributed the turning force on the crank-pin over a longer portion of its path, which of course tends to lengthen the repair life of the engine.
9. In the two-cylinder type it has decreased the oil consumption, and has even done so in the Woolfe four-cylinder engine.
10. Its smoother and steadier draft on the fire is favorable to the combustion of all kinds of soft coal; and the sparks thrown being smaller and less in number, it lessens the risk to property from destruction by fire.
11. These advantages and economies are gained without having to improve the man handling the engine, less being left to his discretion (or careless indifference) than in the simple engine.

12. Valve motion, of every locomotive type, can be used in its best working and most effective position.

13. A wider elasticity in locomotive design is permitted, as, if desired, side rods can be dispensed with, or articulated engines of 100 tons weight, with independent trucks, used for sharp curves on mountain service, as suggested by Mallet and Brunner. One such engine of 80 long tons is now under construction.

III. *What losses are said to have followed compounding?*

1. In some particular types, as actually proportioned, a loss in starting power of from 15 to 20 per cent. However, loss of power in starting cannot be said to be a defect in the principle of compounding.
2. An increase in the number of parts. They are few and plain in the two-cylinder engine, entailing little outlay in first cost or in repair.
3. A possible, but, this Committee thinks, not probable, increase in the cost of repairs to the boiler per pound of fuel burnt, if higher pressures are used. Positive information on this point is difficult to obtain.
4. An increased cost of repairs to the engine per mile run. This item is not yet large enough to be measurable, after three years' continuous service in the plainer forms of the two-cylinder compounds.
5. A larger percentage of failures on the road due to greater complication and size of parts.
6. Increased reciprocating weights on one side, either not balanced, and so increasing the deflection of the en-

gine, or, if approximately balanced, the balance weight doing injury to the road-bed, etc. The two last sections seem to be pure suppositions, which, after search, we find no evidence to sustain.

7. Want of variability or adaptability to wide extremes in speed, and to amount of work to be performed; so that a large compound does not work as cheaply when hauling light loads, or running without load, as a simple engine does.

It is not proved that a compound, working properly throttled—that is, with steam wire-drawn—may not have actually, as she theoretically has, a wide and economical adaptability. So that if the compound, like any other motor, be not as economical when exerting low power as when exerting full power, it probably will use less steam than the simple engine of same weight, working under similar conditions of light haulage duty.

However, the one thing certain about American conditions is that no large portion of our motive power does run lightly loaded, and until we have a wider experimental experience, it is not recommended that all locomotives, doing branch and local light service, be built compound.

IV. *What is the increased cost per engine?*

Von Borries makes the cost of a compound engine of his design from 2 to 5 per cent. cheaper than an ordinary engine of the same power. Where the same boiler is kept a compound engine would be 2 or 3 per cent. heavier and 4 or 5 per cent. more costly, without making allowances for any gain in power. Others estimate the cost of the two-cylinder compound as differing from an ordinary engine chiefly by the cost of the intercepting valve and receiver. The cost of the three-cylinder compound would be from \$1,000 to \$1,250 greater than that of the ordinary engine, on account of the increased number of parts.

The cost of changing simple to two-cylinder compound engines need not exceed \$250 to \$300 each, if the expense of drawings, patterns and templates be divided over a series of engines. The additional cost of building a two-cylinder engine, with receiver, etc., as used by the Michigan Central Railroad, or the ingenious form of four-cylinder engine, as used by the Baltimore & Ohio Railroad, need be little, if anything, over \$200 (excluding royalties), or say from 2 to 2½ per cent. increase on the cost of a simple engine.

V. *Does the saving more than balance the increased first cost?*

If, for convenience, the fuel saving be taken at 17 per cent., or ¼, and the gross consumption at 900 tons per year, with coal at \$1.50 per ton, the decrease in the annual fuel bill is but \$225—certainly not a wide margin to cover contingencies. If, however, at first only the more powerful engines are compounded, whose consumption averages 1,200 tons per year, and coal, as is common, costs on tender \$3 per ton, the saving on fuel is \$600, or 2 cents per mile on a mileage of 30,000 per annum. As this amount would cover not only reasonable interest on first cost, but also allow for about 33 per cent. increase in total expenditure for motive power, repairs and renewals, the saving is certainly enough to permit a possible, but, we think, not a probable, largely increased cost of engine repairs, and yet have a margin of saving on the final balance sheet to the credit of the compound.

VI. *What are "American Conditions" for locomotive service? Can the compound engine meet them?*

We have given this section a large amount of attention, because it has so often been said that the compound must, to be successful on this continent, be adapted to suit American conditions, and your Committee naturally were desirous of fully understanding these conditions. They have not been specified by those making the assertion; and we must reluctantly confess to having failed to identify, much less define them, so that after a long, unsatisfactory chase, they appear to us to be somewhat mythical. If any member can, and will, specify them, he will confer a favor, at least upon the Committee, if not upon the Association.

If an American condition be large starting power, then the Mallet two-cylinder and all four-cylinder engines easily have cylinder power in excess of their adhesive weight. If American conditions be ability to do satisfactory work on a second-rate or third-rate road-bed, or simplicity of con-

struction, or easy accessibility of parts, then these conditions are met by any two-cylinder engine, or by the Baltimore & Ohio four-cylinder engine.

Apparently neither climate nor men are factors in this equation, as compounds are a success in the hands of ordinary enginemen in partially civilized countries; and in hot climates, as well as in Russia, under conditions of low temperature and snow as trying as those ordinarily met with inside of 51°, the present northern limit of our railroad belt.

VII. Is it an essential defect of compound locomotives that they must be short of starting power?

Certainly not! The starting power of the Malett type is at least equal to that of a simple engine of the same weight, and its cylinder power can easily be made to exceed it, by allowing more than half boiler pressure in the large cylinder for the first few revolutions. In the Von Borries, Worsdell, Pitkin and other two-cylinder types, and the Lepage three-cylinder engine, their starting power (as Professor Woods has graphically illustrated), at 170 lbs., may be greater than that of a simple engine at 150 lbs., having cylinders of the same size as the high pressure *during the first half revolution*, but that after this the power (at low speed) of the compound diminishes to 80 or 85 per cent. of that of the simple engine. This conclusion is modified and improved by the knowledge that all two-cylinder engines originally designed as compounds have, or should have, their small cylinder larger than the cylinder of the simple engine of corresponding weight or duty.

It is possible, with the Lindner or equivalent form of starting valve—and a painstaking engineman—to get about 90 per cent. of the starting power of a corresponding simple engine. The Webb type of three-cylinder engine (except with the low-pressure crank dead on center) has cylinder power enough to slip both pairs of wheels, and no higher starting power is desirable. What may be called the opposite form of three-cylinder engine (the Sauvage type), with cylinders of approximately the same diameter as used on the Northern Railroad of France, has ample starting power, because the full boiler pressure is admitted direct to the two low-pressure cylinders. In fact, if desired, the locomotive can be continuously so worked—that is, as a simple engine. Tandem and other forms of four-cylinder engines are not wanting in starting power. The Baltimore & Ohio engine in starting, with a gear as simple as the water-tap gear, puts the small piston practically into equilibrium, and thus admits high-pressure steam to the large cylinder.

A mean effective pressure of 90 lbs. in a simple 18 × 24-in. engine will start a train of 13 coaches on a level in a lively fashion, and a compound can easily give the equivalent of that total pressure without being over-cylindrical.

Going back to the two-cylinder style of engine, with automatic intercepting valve and limited size of cylinder, it would seem as if all of them were capable of getting into motion the load they were designed to haul at full speed, so that their limitations are that they do not get away quite as smartly, quite as noisily, or with the same tearing effort on fire and fire-box as do certain simple engines that waste both fuel and steam in starting. The comparative difference, in time or distance, required by this class of compound to attain maximum speed, has not yet been shown by experiment, but is probably less than is generally supposed.

Mr. Urquhart, desiring to settle the question of the tractive power of simple engines altered to compound, with one cylinder unchanged and with boiler pressure unchanged, carried out tests, using both indicator and dynamometer; and he reports that at a speed of 10 miles per hour the compound passenger engine suffered the following diminution: In first notch, 42 per cent.; in second notch, 28 per cent.; in third notch, 17 per cent.; in fourth notch, 7 per cent.; and in fifth notch, or full gear, 5 per cent. And a similar test of the freight compound showed, in the first notch, 27 per cent. loss; and in the fourth notch, or full gear, 5 per cent. He goes on to say that, for all practical purposes, in full gear a 5 per cent. difference at this speed may be neglected.

VIII. General statements and questions.

A recent press notice credits Mr. Webb with an attempt to

reduce first cost by throwing away the valve gear for the low-pressure cylinder, and using in its place a single loose reversing eccentric—in other words, with an attempt to use an invariable cut-off for the large cylinder. And such practice is not unreasonable, if it from the first be acknowledged that the compound is designed for doing a maximum specific duty with high economy, and, therefore, the valve gear cannot be, and is not, arranged for a wide variability of service.

This intention in design most clearly marks all those engines using but one valve, or one valve stem, to distribute the steam to both high and low-pressure cylinders; such, for instance, as the Vauclain piston valve, the Woolfe hollow D-valve, and the Dunbar single valve stem. In the two first mentioned most ingenious valves, the release of the high-pressure cylinder must be at the same moment as the admission to the low-pressure, or it is no actual release; and the cut-off in the low-pressure cylinder marks the exact point when compression in the high-pressure cylinder commences, there being no appreciable receiver capacity in the valves themselves, large as the passages through them have to be. There is, then, it is clear, little elasticity of adjustment in such valves and gears. The cut-off being early in the small cylinder, it must be early in the large, and as a result the compression in the small cylinder is enormous. Thus the conclusion is again brought home to us that the control of the compound, when small horse power is to be developed, must be chiefly through the throttle wire-drawing the steam, and thus reducing the initial pressure.

Putting emphasis on this truth will not frighten those who are familiar with the fact that wire-drawing is common to-day with our best enginemen. And it may here be noted that the *imperative necessity* for this so-called crude practice is the full explanation for the slight use in modern locomotives of screw and other finely divided reversing gears. This statement opens up the whole matter of cylinder condensation, but it is too large a matter to be properly treated in this report.

However, such modern experimenters as Westinghouse, Kennedy, etc., prove that wire-drawing the admission into cylinders of large surface and small volume is more economical than valve cut-offs at less than 50 per cent. of the stroke.

There are some constructive details and peculiarities about compounds that may deserve special mention. For instance, it is judicious to put safety or relief valves on the low-pressure chest or cylinder, but they should be so located or guarded that in case they came into action, they should not smother the engineman with steam, and obscure his vision. All types do not require water-taps on both cylinders, but most receivers should be so drained. If an intercepting valve is used a reducing valve is not required, and if an intercepting valve is not used, there must be a valve to give independent exhaust direct to the atmosphere from the high-pressure cylinder. The weight of evidence, so far, is in favor of the use of an intermediate receiver. Such a device effectually isolates the cylinders, so that each retains its distinctive temperature. The general practice of drying the intermediate steam by putting the receiver in the smoke-box has much to recommend it. Copper pipes, set close to the curve of the smoke-box, are not cumbersome or much in the way; and if it be desired that the feed-water also be heated in the smoke-box, the large receiver pipes need not interfere with the details of such an arrangement. Receiver capacity cannot, under our limiting conditions, be too large. It should never be less than 1½ times the volume of the high-pressure cylinder, and 2 or more volumes are desirable; because, with a liberal receiver, the steam supply to the low-pressure cylinder is more uniform in pressure and amount, the reheating or drying of the steam is more thoroughly done, and the drop in pressure between high-pressure final and low-pressure initial is less detrimental to steam economy.

If one side of a compound should break down, the other side can be run as a single cylinder engine, if the failure is not due to a total collapse of the cylinder on the side to be blocked. And in a tandem, as in a simple engine, the failure on one side may be a total collapse, without its interfering with the use of the other side as a single engine.

THE LATEST ENGLISH CRUISER.

THE accompanying illustration, from *Industries*, shows the cruiser *Latona*, recently launched from the works of the Naval Construction & Armament Company, Barrow-in-Furness, England. This ship is the first of 29 cruisers of a new class, the construction of which was authorized by Parliament last year, 12 of them to be built in navy yards and 19 by contract.

The dimensions of the *Latona* are: Length, 300 ft.; beam, 43 ft.; depth of hold, 22 ft. 9 in.; mean draft, 16 ft. 6 in.; displacement, 3,400 tons. The hull throughout is built of steel, the stern-post being of cast steel. The ship is not armored, but has a protective deck of steel, arched in form, the crown being 1 ft. above the water-line at the center and sloping down to a point about 4 ft. below the load-line at the sides. This deck is 1 in. thick on the crown and 2 in. on the slope and covers the engine and boilers, the steering gear and the magazines. The upper part of the engines, however, projects above this deck, and

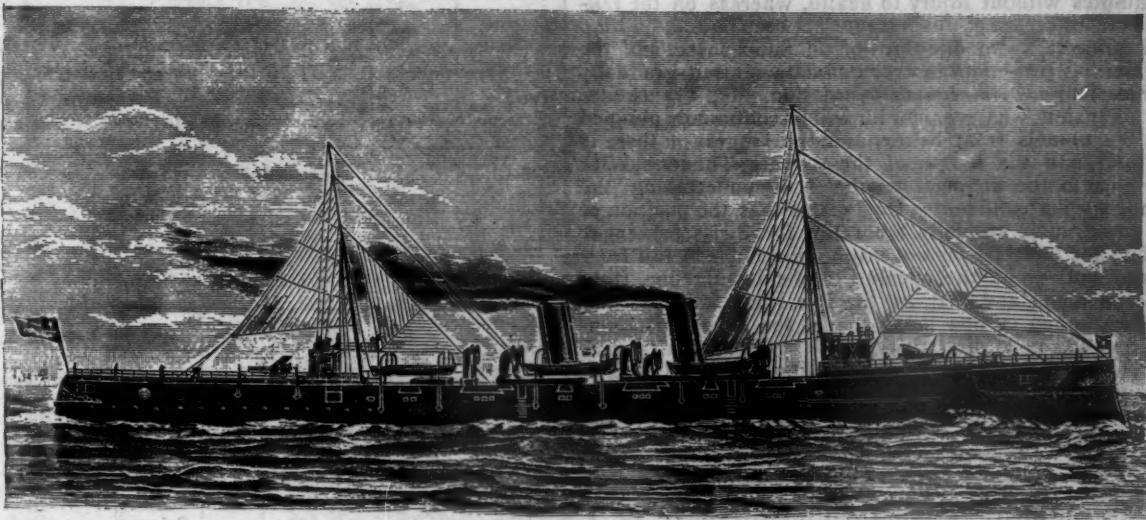
THE PROPOSED JUNGFRAU RAILROAD.

ONE of the most remarkable mountain lines in existence will be the railroad up the Jungfrau in Switzerland, if built on the plans proposed by Mr. Trautweiler. A description of his plan is given below, condensed from the *Wochen-schrift* of the Austrian Engineers' & Architects' Union.

The line is to start from a point near Lauterbrunnen, at an elevation of 2,850 ft. above the sea; it will be 4.29 miles long, extending to a point 100 ft. below the summit, at an elevation of 10,690 ft. above the starting-point.

It will be entirely in tunnel, averaging 50 ft. below the surface, and will be divided into four sections. The first and steepest, up the west face of the mountain, will be about 4,500 ft. long, with a grade of 98 per cent. The second section will be 6,000 ft. long, with a grade of 48 per cent.; the third, 6,150 ft. long, with a grade of 67 per cent.; the fourth, 4,600 ft. long, with a grade of 33 per cent.

The tunnels are to be 8 ft. 10 in. wide in the clear and 9 ft. 6 in. high, with flat roof and cut stone lining about 8



THE NEW CRUISER "LATONA," FOR THE BRITISH NAVY.

is covered by a belt of 5 in. steel armor with 7 in. teak backing.

The *Latona* is divided into numerous water-tight compartments, and has a complete double bottom. The arrangement of the coal bunkers is such as to afford additional protection to the machinery. There are two magazines forward and aft of the machinery compartments. A conning-tower of steel is placed on the after end of the forecastle, and is so arranged that all the workings of the ship can be directed from it.

The armament will consist of two 6-in. breech-loading rifles on pivot mounts, one on the forecastle and one on the poop; six 4.7-in. rapid-fire guns, three on each broadside; eight 6-pounder rapid-fire guns, four on each broadside; one 3-pounder Hotchkiss and 4 Nordenfelt machine guns mounted on deck. In addition to the guns the ship has four torpedo tubes, one forward, one aft and one on each broadside.

The ship has two screws, each driven by a direct-acting, vertical, triple-expansion engine with cylinders 33½ in., 49 in. and 74 in. in diameter and 36 in. stroke. Six engines are expected to develop 9,000 H.P. under forced draft. The forced draft will be on the closed stokehold system, each stokehold being fitted with two powerful blowers driven by independent engines. The ship is also fully supplied with pumps of different kinds, with ventilation for the quarters, and with a complete electric-light plant, including powerful search lights.

The *Latona* has two pole masts, with a light fore-and-aft rig. The full complement will include 252 officers and men,

in. thick. The line will be single track, 1 m. (3.28 ft.) gauge, and a rack-rail will be laid in the center on which the automatic brakes will work.

The cars will have three compartments, each with seats for six persons; they will be about 7 ft. 3 in. wide. The cars will be lighted by electricity.

The stations, three in number besides the terminals, will be cut out of the rock and arched over; each will have room for about 50 persons, and will be provided with a buffet. From the stations inclined passages, from 60 to 300 ft. long, will extend to the surface, so that passengers who wish to do so can stop at any of them and go to the surface to enjoy the view. These passages will be provided with double doors, to exclude drafts.

The road will be a cable line, the cable being worked from a drum at the top. This drum will be driven by compressed air, which is adopted because, as air must be pumped into the tunnels during their excavation on account of the workmen, and continued after the line is opened, there will be economy in this arrangement. The compressors will be about 1½ miles distant from the starting-point of the line, and the air will be conveyed in wrought-iron pipes. The cost of the project is given at \$1,120,000, and time of completing the line, five years; and the returns are based on an assumed passenger traffic of 8,000 per annum, at a cost for the round trip of \$13.

As might have been expected, strong objections to this undertaking were soon made by physicians, meteorologists, and also by the Swiss Alpine Club, and these objections may be classified as follows:

The tunnels in winter—and even in unfavorable summers—will be full of snow and ice. The water trickling through into the tunnels will freeze, and on thawing in the spring season will work mischief. The cold and drafts in the tunnels will be unbearable. The difference of barometric or air pressure during the ascent will produce sickness and dizziness, and there will be a sad want of proper ventilation. No doubt whatever was expressed as regards the practicability of the engineering details of the work, but it was strongly maintained that the line could never pay. Mr. Trautweiler meets all these objections *seriatim*, and states that, as the line will be entirely underground, snow and ice cannot affect it; that the water trickling through will be of the temperature in the tunnel, which, at a depth of 50 ft. below the surface, will never be at freezing-point, and that such an amount of cold is much more favorable for working in than the excessive heat met with, for example, in the St. Gothard tunnel; that the side passages, or ramps, will be closed by double or triple doors, and thus exclude drafts; that the changes of air pressure are not so great or so sudden as in pneumatic foundations, where the workmen are suddenly subjected to a pressure of three or four atmospheres, under which they work for 40 minutes without injury to health, whereas on the railroad the difference of air-pressure between bottom and top of the line is about one-third of an atmosphere, and the traveler has two hours to accommodate himself gradually to the change. As regards ventilation, Mr. Trautweiler has no anxiety whatever, for air will be continually pumped into the tunnels from below, and the longest of these is not one-sixth the length of the Arlberg Tunnel. With reference to the financial results of the undertaking, the author speaks confidently, and states that the position of the Jungfrau is specially favorable for Swiss passenger traffic; for Interlaken is not only approachable by rail from Berne, but, since the opening of the Brünig line, from Lucerne also; and that, as the line from Interlaken to Lauterbrunnen is now being made, the Jungfrau mountain line will be in direct junction with the most attractive and most largely visited parts of Switzerland, and he is of opinion that it will be as much frequented as the Gaisberg is from Salzburg, and the Mendel from Botzen, whatever the weather may be.

INTEROCEANIC COMMUNICATION BY WAY OF THE AMERICAN ISTHMUS.

BY LIEUTENANT HENRY H. BARROLL, U.S.N.

(Continued from page 253.)

XXV.—THE DE LESSEPS PANAMA CANAL.

THIS canal follows the general course of that proposed in 1875 by Commander Lull for a lock canal, but is located nearer the river beds.

The scheme originally involved an open cut, through the isthmus, at a uniform depth of 28 ft. below the low tide levels of the oceans.

A tide-lock is necessary at the Pacific terminus. The total length of the canal, from sea to sea, is 45.5 miles.

The dimensions were as follows: Width at bottom, 72 ft.; width at water surface, 164 ft.; depth, 28 ft.

In the heavy cutting through the dividing ridge, and which is known as the "Culebra Cut," the dimensions were somewhat different, being: Width at bottom, 79 ft.; width at water surface, 85.5 ft.; depth, 29.4 ft.

The estimates for the excavation, etc., of this canal, were made by a committee of nine engineers, as follows:

G. M. Totten,
J. Dirks,
E. Boutan,
W. W. Wright,
V. Dauzats,
Pedro J. Sosa,
Alejandro Ortega,
A. Couvreaux, fils,
Gaston Blanchet.

This committee adopted as the scale of prices to be used in the computation that fixed by the Paris Conference.

The line between Aspinwall and Panama was divided into three sections, and the estimated quantities to be excavated were tabulated as follows:

GENERAL ESTIMATE OF QUANTITIES.

SECTION.	UNDER WATER.			ABOVE WATER.		
	Earth.	Hard Soil Capable of being Dredged.	Hard Rocks.	Earth.	Rocks of Mean Hardness.	Hard Rocks.
	Cubic Metres.	Cubic Metres.	Cubic Metres.	Cubic Metres.	Cubic Metres.	Cubic Metres.
Atlantic Section.	9,330,000	300,000	3,775,000	23,710,000	825,000	3,060,000
Culebra Section.	.....	.....	2,634,000	2,167,000	.....	23,190,000
Pacific Section.	2,675,000	.....	377,000	1,473,000	.....	1,475,000
Total....	12,005,000	300,000	6,786,000	27,350,000	825,000	27,734,000

Grand total, 75,000,000 cubic metres.

GENERAL ESTIMATE OF COST.

WORK.	Quantities.	Rate per Cubic Metre in Francs.	Total Cost in Francs.
1. Excavations, including sidings:			
A. Above water.	Cub. m.		
Earth	27,350,000	2.50	68,760,000
Rock, mean hardness.....	825,000	7.00	5,775,000
Rock, hard.....	27,734,000	12.00	332,808,000
Rock, where pumping is necessary.....	6,409,000	18.00	115,362,000
B. Under water and dredging.			
Mud and alluvial soil....	12,005,000	2.50	30,500,000
Hard soil capable of being dredged.....	300,000	12.00	3,600,000
Rocks.....	377,000	35.00	13,195,000
Total excavation.....	75,000,000	.....	570,000,000
2. Dam at Gamboa:			
Length of crest, 1,600 m.; max. height, 40 m.....	.....	.....	100,000,000
3. Channels for regulating rivers:			
Chagres, Obispo and Trinidad rivers. . .	.....	.....	75,000,000
4. Tide-lock:			
Pacific terminus .....	.....	.....	12,000,000
5. Breakwater:			
Bay of Limon (Aspinwall).....	.....	.....	10,000,000
Total .....	.....	.....	767,000,000
Add 10 per cent for contingencies.....	.....	.....	76,700,000
Total, in francs.....	.....	.....	843,700,000
Or, at 5 francs to the dollar.....	.....	.....	\$168,740,000

To this had to be added the cost of the concession which had been secured by the agents of the Société Internationale; also the cost of administration, the interest on dormant capital, the stockholders' guaranteed premium dur-

ing the construction of the work, and the amount paid for the purchase of the Panama Railroad.

It is difficult to even estimate the amount that has been spent in this undertaking, owing to the inability to understand the methods which have been pursued by the Canal Company; but the amount will not at present fall far short of \$400,000,000.

In its earliest inception the following advantages were claimed for this route; at that time, the intention of its constructors being to build a tide-level canal:

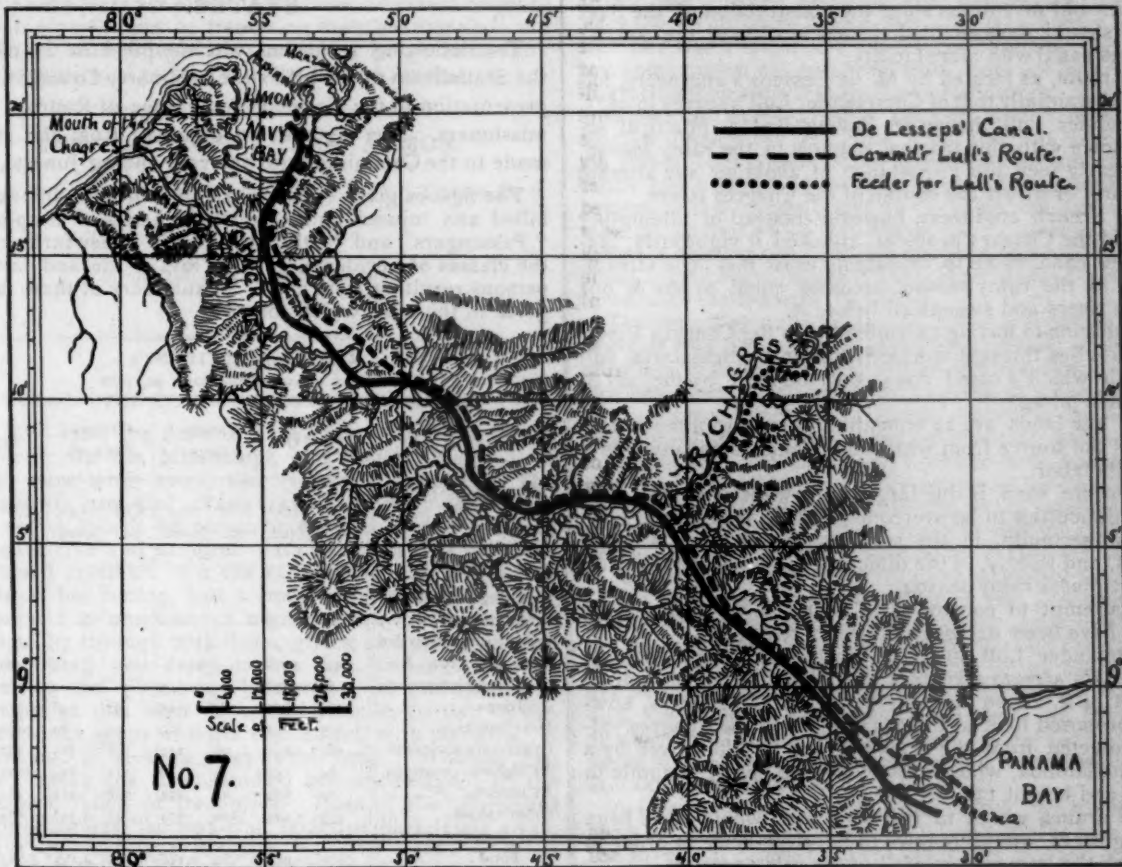
1. That it is the shortest of the practicable routes.
2. That it would cost less than any other canal, offering the same advantages (supposedly being a tide-level canal).
3. That it could be constructed in less time than any other canal.
4. That the cost of its maintenance would be less.
5. That it would be more easily preserved from obstructions.

Chagres River into the sea-level canal was therefore claimed to be impracticable.

The Company's scheme to cross the Chagres River at sea-level was also considered to be an unwise measure. It was proposed to lead the canal across that river at sea-level, the waters of the river being led away by an artificial channel. A dam was to be constructed 132 ft. in height, and 5,248 ft. (nearly one mile) in length; the foundation for which could not certainly be relied upon throughout this great length.

The basin thus formed would hold 1,300,000,000 cubic yards of water. This is equal in volume to that of the greatest recorded flood in this region; but in event of two floods occurring in close succession, the basin would overflow into the canal and cause its destruction.

4. The cost of maintenance must necessarily be great, if any attempt is made to control so large a system of artificial drainage.



6. That it has ports at its termini.
7. That it runs through an inhabited country.
8. That there is already a railroad along the entire route of the canal.
9. That a sea-level canal is the only kind that would satisfy the demands of commerce.

The opponents of the scheme claimed:

1. That it was not the shortest practicable route, a sea-level canal across San Blas being 15 miles shorter.
2. It costs more to construct a sea-level canal than one with a few locks; and as it is necessary to have one tidal lock anyhow, this limits as effectually and in the same degree the number of ships that could pass through the canal as would five or six locks.
3. The average rainfall amounts to over 12 ft. annually, and is not distributed evenly throughout the year, but all of the precipitation occurs within a period of 7 months, at most. A rainfall of 64 in. in 6 hours has been noted. The consequent heavy floods cause the Chagres River to rise 30 to 40 ft. in a few hours. The original plan contemplated a canal at sea-level; and this would have had to be the ultimate drain of all of this valley. The admitting of the

5. The harbor at Aspinwall is subject to severe "Northers," necessitating expensive breakwaters.

6. The cost of excavation would be greatly increased for a sea-level canal, owing to the great distance necessary to lift materials out of the cut; or to which it would be necessary to carry, before finally depositing them.

Trautwine estimates that when excavation costs 10 cents per cubic yard when deposited within 25 ft., it will cost 57 cents when carried a distance of one mile, and 98 cents when carried two miles. It is of the utmost importance in the case of a sea-level canal that the material excavated be placed at such a distance as to preclude its being washed back into the canal. Finally, a sea-level canal leaves but little chance for the utilizing of the excavated material in fills or embankments.

This objection was, of course, removed when the Panama Canal Company, recognizing the impossibility of continuing their original scheme, commenced the construction of a Lock-canal.

7. The allowance of 10 per cent. for contingencies is never considered by American engineers as sufficient, especially in a country so little known and so little inhab-

ited as Panama. In estimating the cost of a canal by way of Nicaragua, the United States Canal Commissioners rejected the 25 per cent. usually allowed by engineers, and applied 100 per cent. instead. Treating the estimated cost of the Panama Canal, as given by its computers, in this same way the probable cost would amount to \$306,800,000.

8. The calms of Panama Bay would cause vexatious and expensive delays to all sailing vessels.

Notwithstanding the clearness with which these objections were placed before the Paris Conference, that body yet decided upon Panama as the proper location for the canal.

The failure of the French Company to pierce the Isthmus at this point, although directed by that able engineer De Lesseps, has been so pronounced that it is well to examine as closely as possible the causes which have led to the same in the hands of one who so successfully connected the Eastern oceans.

The vast strides that have been made in mechanical appliances and inventions since the construction of the Suez Canal should have enabled the excavation of the greater Isthmus-canal with more facility.

The route, as located by M. de Lesseps's engineers, follows substantially that of Commander Lull's survey in 1875. Commander Lull, however, having had a practical acquaintance with this tropical country in the rainy season, had clearly seen the importance of avoiding any attempt to control or divert the course of the Chagres River.

The French engineers, however, instead of attempting to avoid the Chagres problem, attacked it vigorously, laying their canal-route to repeatedly cross this little stream, which in the rainy season becomes equal to one of our largest rivers and sweeps all before it.

In addition to having to contend with the Chagres River, the route lies through morasses teeming with malaria, and through which a canal could only be built by the aid of expensive piling.

The low lands are so unhealthy as to have almost devastated the source from which the Canal Company would draw its labor.

Its failure, then, is due largely to a want of appreciation of the difficulties to be overcome, first, in the climatic conditions; secondly, in the social status of the laboring classes, and thirdly, in the difficulties to be contended with in the tropical rainy season.

An attempt to control the Chagres River shows what would have been necessary in this water-way.

Commander Lull suggests for the carrying of a canal across this stream a viaduct which shall have its bottom at least 44 ft. above the river's bed. M. de Lesseps, however, proposed to lead the canal through the Chagres valley, protected from the floods which fill that river by a dam at Gamboa, whose crest would be nearly one mile in length and height 132 feet!

Side drains, which in the dry season would have been mere gutters, would require to be river-beds in order to carry off the immense rainfall of the rainy season.

Again, while in the construction of the Suez Canal the engineer had his labor driven to the task of excavating the sands, and no mutiny or objection was tolerated by the stern and absolute Khedive; in Panama the free Jamaican or Colombian rebels against working knee-deep in malarious slime, except at wages for which *he* fixes the price; and contractors' bids are always based directly upon the price of labor.

There had been, apparently, no arrangement made for sanitarium or hospital buildings, and when in 1881 ground was first broken for the canal, some 60 engineers and assistants and hundreds of workmen were at once stricken down with malarious, or "Chagres" fever.

This fever finds ready victims in the foreign element, fresh from healthful countries, and unfitted to combat its insidious attacks. It is considered almost as dangerous as yellow fever, and although not contagious, is epidemic and is always present at Panama.

The enervating climate requires at least two or three persons, well overlooked, to perform the work that one man would do in a more bracing climate; while the overseer himself must at short intervals be renewed, that *his* energy does not deteriorate.

The Chagres River has been made to bear the burden of all of the disaster which has attended this attempt at canal-making. It is really but one of several causes, any of which would have been sufficient to have brought about its failure.

M. de Lesseps, while probably not realizing a dollar of profit from this work, is yet responsible for the immense loss to the French people, who enthusiastically subscribed to the scheme which was headed by his illustrious name.

Even had there been no other possible route, and with the resources of all of the civilized nations of the world, it is doubtful if a canal could have been cut through, after the manner adopted by this company. It certainly could not have been completed at a cost which would have ever allowed the profits to remunerate its stockholders.

(TO BE CONTINUED.)

RAILROAD ACCIDENTS IN THE UNITED STATES.

THE following statement was compiled in the office of the Statistician to the Interstate Commerce Commission for presentation to the National Conference of Railroad Commissioners. The figures are obtained from the returns made to the Commission for the year ending June 30, 1889.

The figures given below make an exhibit of the number killed and injured under the three heads, "Employés," "Passengers" and "Other Persons." They further show the classes of accidents, and the loss of life and injury to persons resulting from each. A summary of these facts is given in the table which follows:

RAILROAD ACCIDENTS
FOR THE YEAR ENDING JUNE 30, 1889.

KIND OF ACCIDENT.	EMPLOYÉS.		PASSENGERS.		OTHER PERSONS.		TOTAL.	
	Kill- ed.	In- jured.	Kill- ed.	In- jured.	Kill- ed.	In- jured.	Kill- ed.	In- jured.
Coupling and uncoupling cars.....	300	6,757	.....	.....	.....	.....	300	6,757
Falling from trains and engines.....	493	2,011	.....	.....	.....	.....	493	2,011
Overhead obstructions	65	296	.....	.....	.....	.....	65	296
Collisions.....	167	820	107	445	37	48	311	1,313
Derailments.....	125	655	28	389	29	69	182	1,113
Other train accidents..	189	1,016	26	247	522	515	737	1,778
At highway crossings.	24	45	3	16	410	634	437	695
At stations.....	70	699	26	295	328	472	424	1,466
Other causes.....	539	7,729	120	754	2,215	2,397	2,874	10,880
Total	1,972	20,028	310	2,146	3,541	4,135	5,823	26,309

The railroads of the United States carried 472,171,343 passengers during the year covered by this statement, from which it appears that one passenger in every 1,523,133 was killed, and one passenger in every 220,024 was injured. For the year 1888, the rate of casualty in England to passengers from railroad accidents was one passenger in 6,942,336 killed, and one passenger in 527,577 injured. In judging of the above figures, it should be noted that passenger mileage for a given number of tickets sold is much greater in the United States than in England, a fact which mitigates somewhat the severity of judgment upon railroad management in the United States disclosed in the above comparison.

In order to appreciate the above exhibit of casualties to employés of railroads, it is necessary to know the number of employés liable to the various sorts of accidents recorded. The total number of railroad employés in the United States is 704,736, which for the present purpose may be divided into Trainmen, Switchmen, Flagmen and Watchmen, and Other Employés. The number of employés in each class, as also the casualties to each class, is given in the following statement:

CASUALTIES TO EMPLOYÉS,
ASSIGNED TO CLASSES NAMED.

CLASS OF EMPLOYÉS.	Number.	Killed.	Injured.	PER CENT OF TOTAL.	
				Killed.	Injured.
Trainmen	137,334	1,179	11,301	0.86	8.23
Switchmen, Flagmen and Watchmen	33,344	229	2,155	0.69	6.46
Other employés	517,820	536	6,360	0.10	1.23
Unclassified	16,238	28	214	0.17	1.32
Total	704,736	1,972	20,030	0.28	2.84

The above facts are presented without comment respecting their significance, or respecting their bearing upon the general question of legislation providing for greater safety in the operation of railroads in the United States.

THE DEVELOPMENT OF ARMOR.

BY FIRST LIEUTENANT JOSEPH M. CALIFF, THIRD U. S. ARTILLERY.

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(Continued from page 266.)

XIII.—THE TEST OF BATTLE (continued).

In July, 1862, the fleets of Flag-Officer Farragut, which had come up the Mississippi, and that of Flag-Officer Davis, were lying above the Vicksburg batteries. The Confederate iron-clad *Arkansas* was lying up the Yazoo. This vessel, it will be remembered, was of the ordinary casemate type and armored with common railroad iron, dovetailed together. On the 15th of the month she came out from her hiding, had a running fight with two gun-boats on a reconnoissance up the river, fought her way successfully through both fleets, giving and taking the fire of everything that came in her way, and reached the shelter of the Vicksburg batteries. So mortified was Farragut at this bold dash, that later in the day he ran the batteries again with his entire fleet, with the object of destroying, if possible, the rebel ram. Darkness had fallen before the fleet reached her anchorage, and the movement failed of its object. Most of the projectiles delivered against the iron-clad bounded harmlessly away. Two 11-in. shell got through, however. On the down passage of the fleet a 9-in. shell found its way through. Considering the character of the armor, the number and short range of the projectiles fired against it, one must admit that this was another decided triumph for the iron-clad.

Of the iron-clads in the Union fleet but one seems to figure in the reports—the *Carondelet*—one of the Eads' construction. She had a running fight down the Yazoo, in which she had to present her unarmored stern to the fire of the *Arkansas*, and suffered accordingly. The loss on the fleet was 78 killed, wounded and missing. On the *Arkansas*, 10 killed and 15 wounded. In an engagement with the *Essex* iron-clad a few days later, the latter succeeded in getting a 9-in. shell through her bow armor. Later on her machinery broke down, and she was set on fire to prevent her falling into the hands of the Federals.

The fight in Mobile Bay was in August, 1864, and no better example of the value of armor can be cited. Here a single armored iron-clad—the *Tennessee*—fought for two hours, almost single handed, the entire Federal fleet of three iron-clads and 14 wooden vessels, passing through the fleet, giving and receiving fire at short ranges, and coming out of the fight with armor still in place and not fatally injured. A broadside from the flag-ship of seven

9-in. solid shot at 10 feet distance rattled harmlessly from the 6-in. armor of her side; another broadside from the *Monongahela*, at as many yards, had as little effect. The *Chickasaw*, double-turreted monitor, kept position astern for half an hour, firing 52 solid 11-in. shot at ranges varying from 50 yards to almost touching; the *Manhattan*, another iron-clad, got in six 15-in. shot at short range, and besides nearly every vessel in the fleet had a chance at the Confederate, and yet of all the shower of projectiles hurled at the *Tennessee*, not one got inside the casemate. One of the 15-in. shot from the *Manhattan* broke through the armor-plates and splintered the backing. Under the persistent pounding from the *Chickasaw* most of the plates on the after end of the casemate were loosened, but when the fight was over not one had been detached. Three of her port-shutters had been jammed so that the guns could not be used; her smoke-stack destroyed, and finally her tiller-chains were carried away by a shot, completely disabling her. After enduring the hammering from all sides for 20 minutes longer, her flag was hauled down. Her loss was 2 killed and 10 wounded, among the latter her commander, all resulting from concussion or flying fragments following shot on the port-shutters.

While the iron-clad was passing almost wholly unscathed through the fleet, shot from her guns were crashing through the wooden sides of her antagonists, carrying death and destruction in their path. A very large proportion of the reported loss of 52 killed and 72 wounded may be attributed to the fire of the *Tennessee*, for the losses in passing the forts, except on the *Brooklyn*, were small. The above losses do not include those who went down with the monitor *Tecumseh*.

The monitors were uninjured. It is difficult to understand at this day why the unarmored vessels of the fleet should have hung so closely around the iron-clad, trying to run her down, ramming and engaging at close quarters, when there were three monitors remaining in the fleet, any one of which would have been a fair match for the Confederate. The *Tecumseh*, with her 10-in. turret armor and two 15-in. guns, was at the bottom of the bay, but her consort, the *Manhattan*, with the same armament and armor protection, was at hand, together with the *Chickasaw* and *Winnebago*, from the Mississippi River fleet, carrying each four 11-in. guns and with turret armor of 8½ in.

The short and brilliant career of the *Albemarle* was worthy of the difficulties attending her construction. In her first encounter with the Federal fleet she rammed and sunk the *Southfield*, receiving almost at the muzzle from her and her consort the fire from 100-pounder rifles and 9-in. shell guns. These projectiles broke up harmlessly against her side, and the fragments, coming back upon the decks of the *Miami*, killed her captain and wounded several others of her crew.

A few weeks later a determined effort was made to destroy this troublesome adversary. An officer was sent to the sounds of North Carolina especially charged with this duty. In the struggle that followed, seven Union vessels mounting eight 100-pounder rifles, eighteen 9-in. Dahlgren smooth-bores, and 28 guns of smaller calibers, mostly howitzers, were matched against two 100-pounder rifles behind 4 in. of armor-plate. For nearly three hours the *Albemarle* fought the fleet single handed. First sailing around her, each in turn gave her their broadsides, until, finding this ineffective, they fairly flung themselves upon the iron-clad, crowding in so closely as to prevent effective fire against her. While being rammed by the *Sassacus*, three 100-pounder solid shot were fired into the *Albemarle*, which "were shattered, coming back in fragments upon the deck of the *Sassacus*."

In the fleet one vessel had been disabled by a shot through her boiler and others more or less damaged, with a loss of about 30 killed and wounded, when darkness ended the struggle. The commander of the *Albemarle* reports, "Loss of boats, a riddled smoke-stack, broken plates on the shield, and one gun disabled," but no loss of life and no projectiles inside the turret.

The reports from the commanding officers of four of the vessels engaged show that they threw in this hand-to-hand encounter 60 of the 100-pounder rifle projectiles, principally solid shot, and 173 of the 9-in. smooth-bore projec-

tiles, besides many of smaller caliber. Remembering the hasty manner in which the iron-clad was built and the inferior quality of her material, the showing for the armor-plate is surely a good one.

It has been seen how well the inclined casemate armor of the Western river boats and of the Confederate iron-clads served its purpose. It was in the operations in and about Charleston Harbor and on the Atlantic Coast that the other class of armor-clads—the monitors—were brought to the test of battle. Those of the *Passaic* class saw the most active service. They were single-turreted, with 11-in. turret and 5-in. side armor, in 1-in. plates, and an armament, with some exceptions, of one 11 and one 15-in. Dahlgren.

In the first general attack on the fortifications in Charleston Harbor, April 7, 1863, the iron-clad fleet was represented by seven monitors of the *Passaic* class, the *Keokuk*, a nondescript with thin armor, and the *New Ironsides*, aggregating 32 guns, two-thirds of which were 11-in. Against these were brought an equal number of 8, 9 and 10-in. columbiads, two Brooke and 15 converted rifles—32 and 42-pounders, besides a few mortars and smooth-bore 32 s. Later on, as operations progressed, this number was greatly reduced by the silencing of the guns mounted at Sumter.

Beginning with this general attack on the fortifications in April, and continuing until the fall of Fort Wagner in September, the iron-clad fleet was many times under fire, and often fire of a very trying character. The *Montauk* was 15 times under fire, and on an average each of the monitors was 10 times engaged with the forts. In the attack on Wagner, in July, the *Catskill* alone was struck 60 times. In these encounters the distance varied from 300 to 1,200 yards. During these operations the number of recorded blows upon the armor of the individual iron-clads ran from 36 on that of the *Lehigh* to 214 on the *Montauk*. In the attack of April 7, the *Keokuk* was brought into action between Sumter and Moultrie, and in 30 minutes was struck 90 times, receiving 19 shot at or below the water-line; the turrets were pierced; in short, "the vessel was completely riddled," and sank the following morning.

The behavior of the monitor class of iron-clads was, on the whole, disappointing. After the test of the little *Monitor* in Hampton Roads, it was believed by many that these boats were fully capable of coping with any ordnance mounted along the Southern coast; and from the orders issued for the attack on April 7, it is evident that it was expected in high quarters that the fleet would be able to silence or run by the forts and steam up to the city of Charleston.* The test to which they were subjected was a severe one, and brought out all the weak points in their construction. Without going into the details of the injuries received, it may be said, in general, that the 2-in. deck armor was found to be insufficient, and it was in many instances completely broken through; the manner of securing the side armor by means of blunt bolts was a mistaken one, as the bolts loosened and drew out under severe blows, separating the plates from and sometimes stripping them entirely from the backing; side armor was pierced, and the armor of the turrets in several cases broken through and through, parting the plates in many different places; if struck near the base, the turrets were apt to become jammed, temporarily disabling the vessel. But the greatest defect, or at least the most disastrous, seems to have been the use of through bolts and nuts in setting up the armor on the turrets and pilot-houses. A blow on the outside would send bolt-nuts flying across the turrets like so many projectiles. A very large percentage of the casualties on the fleet during these six months was due to this one cause. The same experience was met with on the casemated iron-clads where this method of

fastening armor was resorted to. Especially was this shown on the *Tennessee* in her action with the fleet in Mobile Bay.

Perhaps the most prominent fact brought out in this battle-test of the iron-clads was that of the superiority of the solid over the laminated armor. Side by side with the 5, 7 and 11-in. built-up armor on the sides, pilot-houses and turrets of the monitors, we have the 4½-in. solid armor-plates of the *New Ironsides*. A single glance at the reports will show this superiority. On the one hand we hear of side armor broken, knocked off, or driven into the backing, the plates separating from each other; 11-in. turret armor broken through and pilot-houses almost wrecked. Against this we have the record of six months of the hardest kind of service on the part of the *New Ironsides*. In addition to the pounding she received with the other iron-clads in the various engagements with the forts, on one occasion she fought them single handed for three hours, and only withdrew when her ammunition was exhausted. No material damage was received, and only two men slightly wounded from iron splinters. Neither in this prime test nor in any other of her engagements was she disabled for an hour; nor was the armor seriously injured at any time. Remembering that in the brief engagement of April 7 five out of the seven iron-clads were, for the time being, partially or wholly disabled, the behavior of this vessel is the more to be admired. In one other particular was the *New Ironsides* superior to the monitors. Her armor was secured to its backing by iron wood screws, after the French system. These screws had a hold of about 13 in. in the backing, and gave perfect satisfaction.

(TO BE CONTINUED.)

THE HUDSON RIVER TUNNEL.

(From *Industries*.)

SOME time after the failure of the first attempt to tunnel under the Hudson River at New York, the abandoned works were visited, in 1888, by Sir Benjamin Baker, who was furnished with information by the Company's representative as to the nature of the soil, cost and rate of progress of the executed tunnelling, and other details. In the same year a joint report, based upon this information, was presented by Sir John Fowler and Sir Benjamin Baker to the directors of the Company, estimating the time for completion at 18 months, and the cost of finishing the northern and southern tunnels at £180,000 and £250,000 respectively. According to this plan, the two parallel tunnels will be each 5,600 ft. in length under the river and, with their approaches, about three miles in length. The tracks will reach Broadway by easy gradients only 16 ft. below its level at the New York end, and will also rise by easy gradients to the street level at Fifteenth Street, at the Jersey City end. Early in the following year an issue of £300,000 in 6 per cent. mortgage bonds, forming the first part of a total authorized issue of £550,000, was made in London for the purpose of carrying out the scheme, and the contract was shortly afterward let to Messrs. S. Pearson & Son, of Westminster, Mr. Hutton, of New York, being the Engineer, and Messrs. Fowler, Baker and Greathead the Consulting Engineers.

Before passing to a detailed account of the shield now to be employed in the execution of this important enterprise, we may briefly state in general terms that the shield is supported against external pressure by vertical girders. The face of the shield is formed as a cutting edge, and horizontal shelves extending across the shield are similarly armed to pass through the material met. Behind the cutting edges the shield is closed by a diaphragm of plates completely separating it into two compartments. In this diaphragm doors are placed which can be opened to admit the material being excavated, and the pressure of compressed air in the tunnel prevents the admission of water. When harder and water-tight material is traversed the doors are opened, and the excavators attack the face of the heading. When a sufficient quantity of material has

* Admiral Dupont, in his report of the first attack of the iron-clads, April 7, says: "I had hoped that the endurance of the iron-clads would have enabled them to have borne any weight of fire to which they might have been exposed; but when I found that so large a portion of them were wholly or one-half disabled by less than an hour's engagement, before attempting to remove the obstructions or testing the power of the torpedoes, I was convinced that persistence in the attack would result in the loss of the greater portion of the iron-clad fleet, and in leaving many of them inside the harbor, to fall into the hands of the enemy."

been removed, hydraulic rams attached to the shield advance it by acting against the lining of the tunnel already completed and in position, and a fresh section of lining is at once added. The illustrations which we give in figs. 1, 2 and 3 herewith show the shield in several stages of erection in Sir William Arrol's Dalmarnock Works, near Glasgow. We need not add any detailed description of the views, as they are sufficiently self-explanatory.

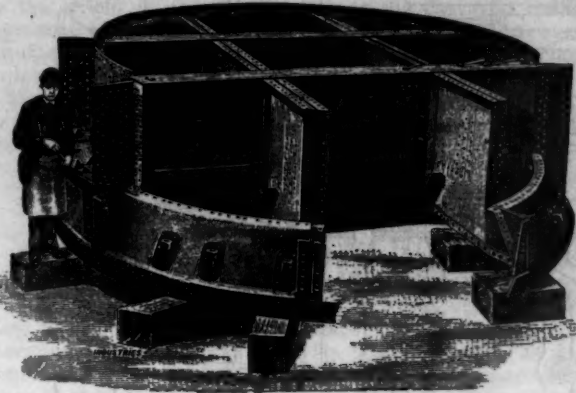


Fig. 1.

We will now turn to details of the shields under consideration. The external diameter is 19 ft. 11 in. by 10 ft. 6 in. from cutting edge to tail of shield. The outer skin is made up of two thicknesses of $\frac{1}{4}$ -in. steel plates, with internal covers, and packing pieces between the covers, all of a similar thickness. A division of plates $\frac{1}{4}$ in. in thickness is placed 5 ft. 8 in. from the cutting edge, and com-

door from the after compartment of the shield. The inner skin of the shield is composed of $\frac{1}{4}$ -in. plating, and extends from the plates forming the division of the shield carrying the doors to within 2 ft. 4 in. of the cutting edge, and is separated from the outer skin by a distance of 1 ft. 5 in. Sixteen diaphragms of $\frac{1}{4}$ -in. plates 3 ft. 2 in. \times 1 ft. 5 in.,

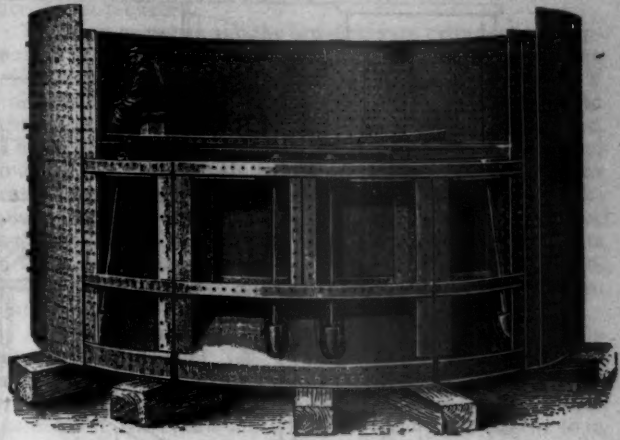


Fig. 2.

with 4-in. \times 4-in. \times $\frac{1}{4}$ -in. angles running completely around on each side, are spaced equidistantly around the shield between the two skins, and arranged to coincide with the attachments of the horizontal and vertical girders already described at their respective junctions with the inner skin. The doors are nine in number, of $\frac{1}{4}$ -in. plates; seven are square and dished, covering openings ranging from 2 ft. 6 in.

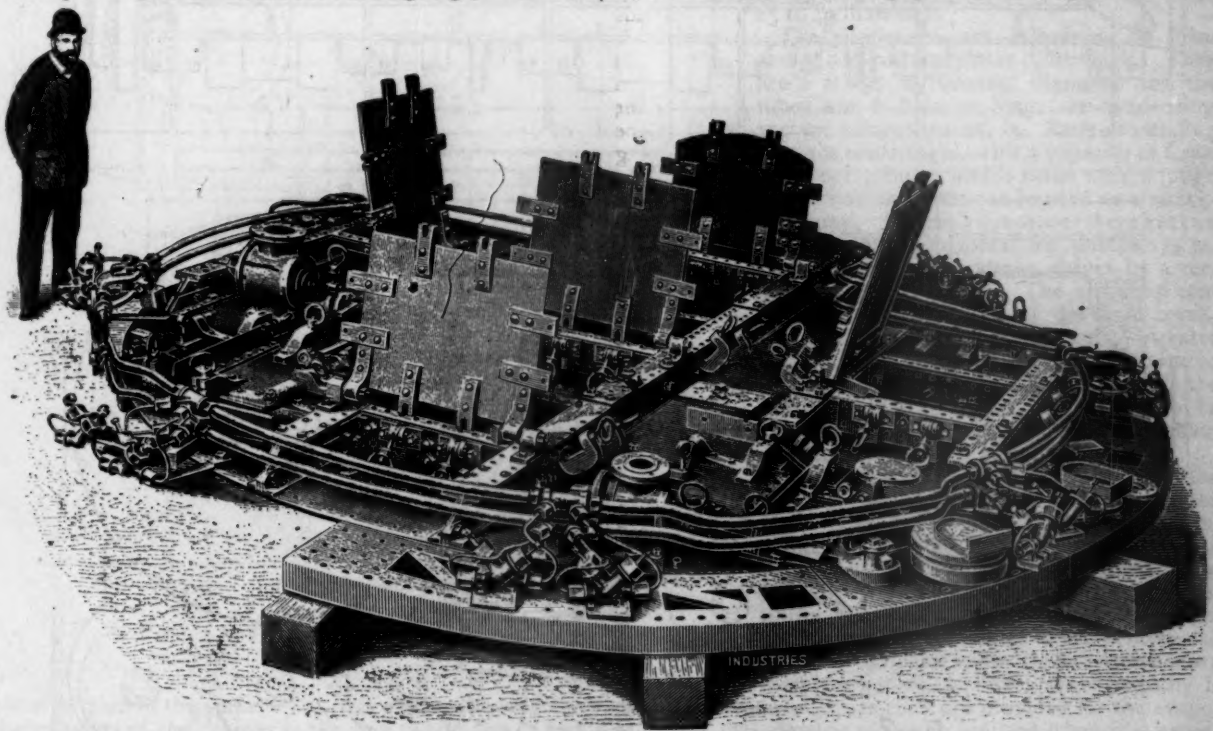
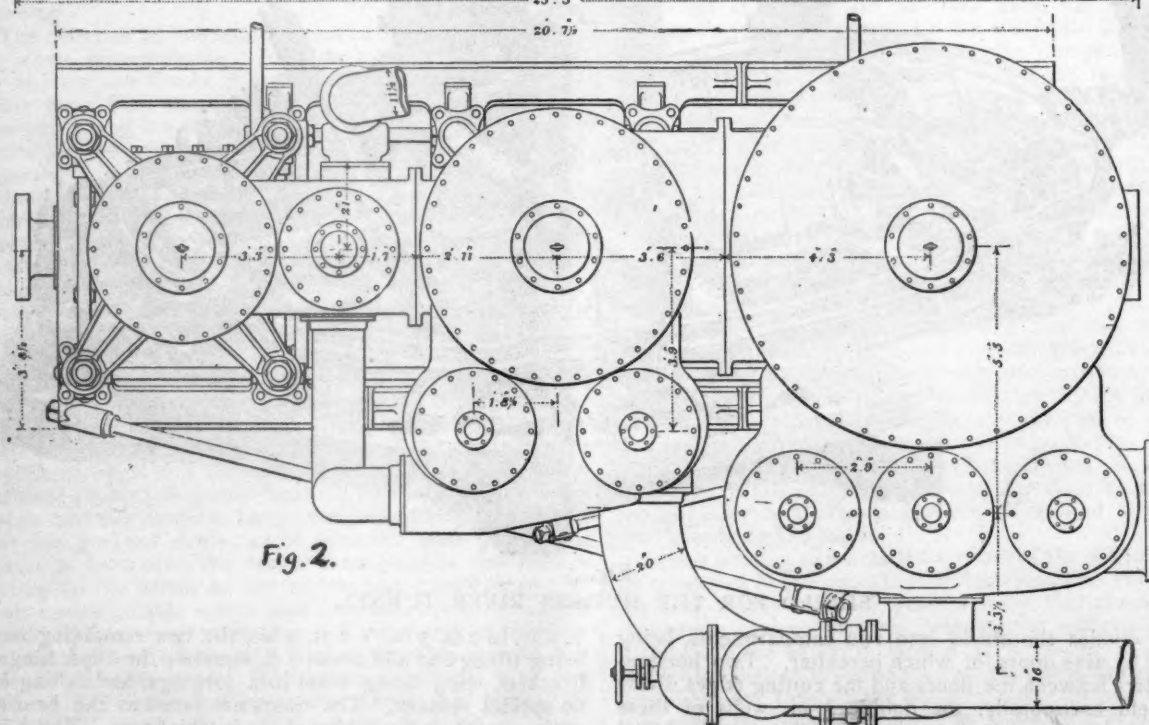
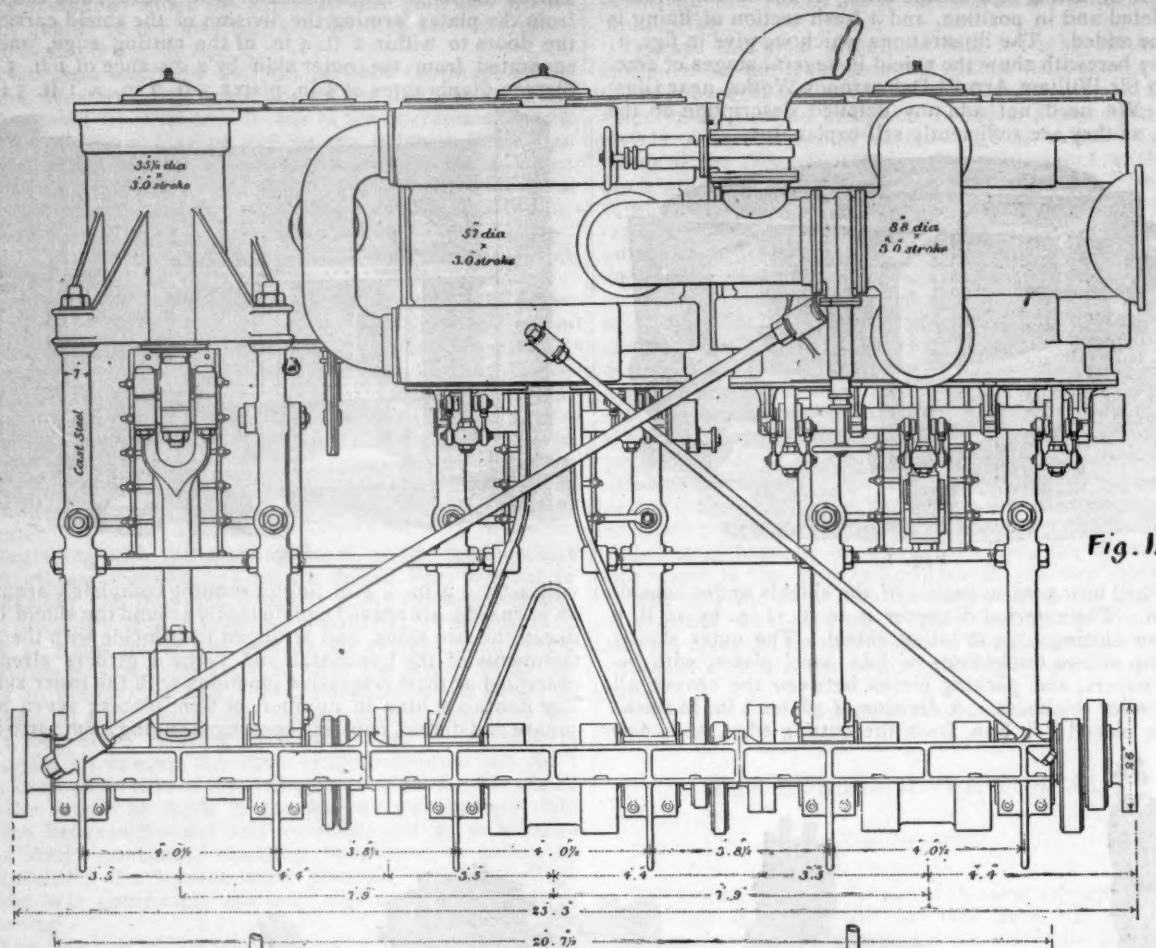


Fig. 3.

SHIELD FOR THE HUDSON RIVER TUNNEL.

pletely divides the shield into two compartments, being pierced by nine doors, of which hereafter. Two horizontal girders between the doors and the cutting edges divide the shield horizontally, the double $\frac{1}{4}$ in. webs of these girders being connected to the door-plates and vertical diaphragms by 6-in. \times 6-in. \times $\frac{1}{4}$ -in. angles. The two vertical diaphragms, which divide the shield similarly throughout its entire height, are built of 4-in. \times 4-in. \times $\frac{1}{4}$ -in. angles and a $\frac{1}{4}$ -in. web. The face of the shield is thus divided by these horizontal and vertical girders into nine cells, access to each of which is gained through a

\times 2 ft. to 2 ft. 3 in. \times 1 ft. 9 in., the two remaining ones being triangular and about 2 ft. square; the clips, hinges, brackets, etc., being stout iron forgings, and calling for no special remark. The doors are faced at the bearing surface with india-rubber $\frac{1}{4}$ in. in thickness. The $\frac{1}{4}$ -in. plates forming the vertical division of the shield are stiffened by six vertical girders 6 $\frac{1}{2}$ in. in depth, and each made up of four 3-in. \times 3-in. \times $\frac{1}{4}$ -in. angles, with a top flange plate 6 $\frac{1}{2}$ in. \times $\frac{1}{4}$ in. and a $\frac{1}{4}$ -in. web. Sixteen cylinders of cast steel are placed between the two skins equidistantly around the shield. They are 3 ft. 4 $\frac{1}{2}$ in. over all, with ex-



TRIPLE EXPANSION ENGINES, ARMORED CRUISER "MAINE."

DESIGNED BY BUREAU OF STEAM ENGINEERING; G. W. MELVILLE, CHIEF OF BUREAU.

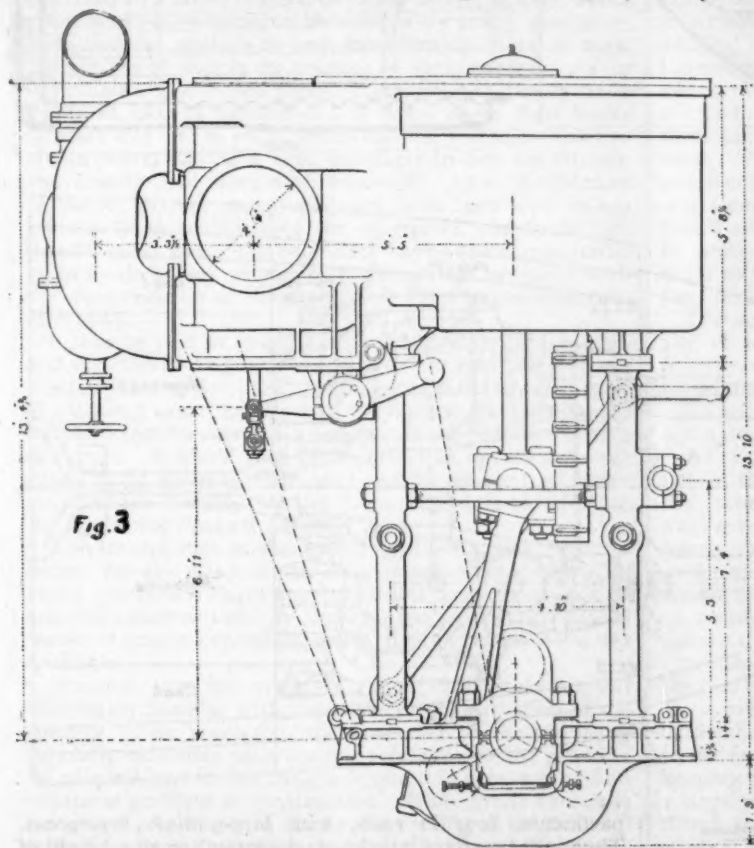
ternal and internal diameters 10½ in. and 8 in. respectively. The rams have an internal diameter of 3½ in.

The cylinders and rams were cast by the Steel Company of Scotland at their Newton Works, and prior to despatch were tested to a pressure of 2 tons per square inch, all cocks, tees, valves, etc., being similarly tested to a like pressure. The shields have been made by Messrs. William Arrol & Co., Dalmarnock Iron Works, Baltic Street, Glasgow. The hydraulic segment erector, which will follow up the shield in the tunnel, placing the cast-iron lining segments in position as the tunnel advances, has been manufactured by Messrs. Fullerton, Hodgart & Barclay, Vulcan Foundry & Engine Works, Paisley, Scotland.

The contractors' agent is Mr. Moir, recently on the Forth Bridge, and the immediate conduct of the works is in his charge.

THE ENGINES OF THE "MAINE."

THE accompanying illustrations show the engines designed by the Bureau of Steam Navigation for the armored cruiser *Maine*, which is now under construction at the New York Navy Yard. In these illustrations, fig. 1 is an elevation; fig. 2, a plan, and fig. 3, an end view of the engine. Fig. 4 is one-half an end view and one-half a cross-section of one of the boilers, while fig. 5 is a longi-



tudinal section of the same. Fig. 6 is a plan showing the arrangements of the engines in the ship, while figs. 7 and 8 are half cross-sections of the ship showing the position of the engines and of the screw shafts. The description of this engine, as given in the Report of the Bureau, is substantially as follows:

The *Maine* has two propelling engines, one for each screw, and both alike. Each engine is of the vertical triple-expansion type, placed in a separate water-tight compartment. The cylinders are 35½ in., 57 in. and 88 in. in diameter by 36 in. stroke, and are intended to work at 132 revolutions per minute when at full speed. The calculated power of the main engines with the air and circulating pump engines is 9,000 H.P.

The principle of the interchangeability of parts, now so

much used in modern practice, is carried in these engines to the fullest extent. All the cylinders have piston valves of the same size—22 in. in diameter—the high-pressure cylinder having one valve, the intermediate cylinder two, and the low-pressure three valves. For each cylinder the valves are worked from a Stephenson double-bar link. The cylinders have working linings of hard cast iron, and are steam-jacketed.

The high-pressure and the low-pressure cylinders are supported by hollow cast-steel columns, and the intermediate cylinder upon straight columns in front and inverted Y columns at the back. These columns are firmly bolted to the cylinder, to the cast steel bed-plate and to each other. The crank shafts are of forged steel, 13 in. in external diameter at the journals, with axial holes 4 in. in diameter extending through the shafts and crank-pins. The crank-pins are 14 in. in diameter. Each shaft is made in three sections, which are interchangeable. The thrust-shafts are 12½ in. in diameter with 6 in. axial holes, and the propeller shafts are 13½ in. in diameter with 6½ in. and 6 in. axial holes.

A special feature of the propelling engines of this ship is the arrangement for disconnecting the low-pressure cylinders when cruising at low speed. These cylinders are placed forward, and provision is made for easily disconnecting the crank-shaft, thus reducing the engine to a two-cylinder compound which can work up nearly to its full power. This arrangement is expected to give an increased economy over the triple-expansion engines at low pressures. A special exhaust pipe leads from the intermediate cylinder to the condenser for use when the low pressure cylinder is disconnected.

The propellers are to be all of manganese or aluminum bronze, three-bladed and about 15 ft. in diameter.

The condensers are cylindrical in form and of composition plates ¾ in. thick. They are 6 ft. 5½ in. internal diameter and the tubes are 8 ft. 4 in. long, the condensing surface being 7,010 sq. ft. Each circulating pump is centrifugal, with a capacity of 8,000 galls. per minute, and is fitted with a bilge connection so that it can be used as a wrecking pump. For each condenser there are two double-acting, horizontal air pumps 17½ in. diameter and 18 in. stroke, driven by a vertical compound engine. The air-pump connecting rods take hold of the same crank-pins as the engine connecting rods. A valve is fitted in each low-pressure exhaust pipe so as to shut off the communication with the condenser and to permit the engine to be used for auxiliary purposes when the main engines are stopped.

Evaporators are fitted for furnishing the steam for the distillers for replenishing the fresh water lost in ordinary running. Connections are fitted from the evaporator to the auxiliary exhaust mains, so that the steam can go direct to the condensers. The distilling plant has a capacity of 5,000 galls. of potable water per day at a temperature of not over 90°, but when the evaporators are used for supplying losses their capacity is

greatly increased. Spare coils are provided for the evaporators, so that clean ones can be inserted when it is necessary to remove the scale from those which have been in use.

The *Maine* is provided with eight single-ended boilers of the ordinary return tubular type, 14 ft. 8 in. in diameter and 10 ft. long, designed for a working pressure of 135 lbs. The outer shells are of mild steel 1½ in. thick. Each boiler has three corrugated steel furnaces 42 in. in diameter, and 519 steel tubes 2½ in. in external diameter and 16 ft. 7 in. long. There are in each boiler 401 plain tubes and 118 stay-tubes, the latter being twice the thickness of the ordinary tubes. The total grate surface is 553 sq. ft. and the total heating surface about 16,800 sq. ft.

The boilers are placed in two separate water-tight com-

Fig. 4.

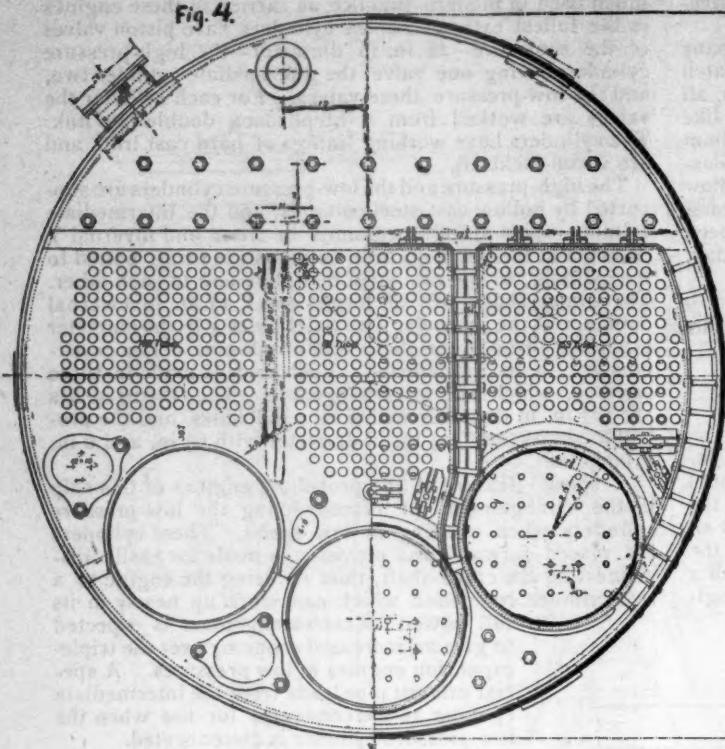


Fig. 5.

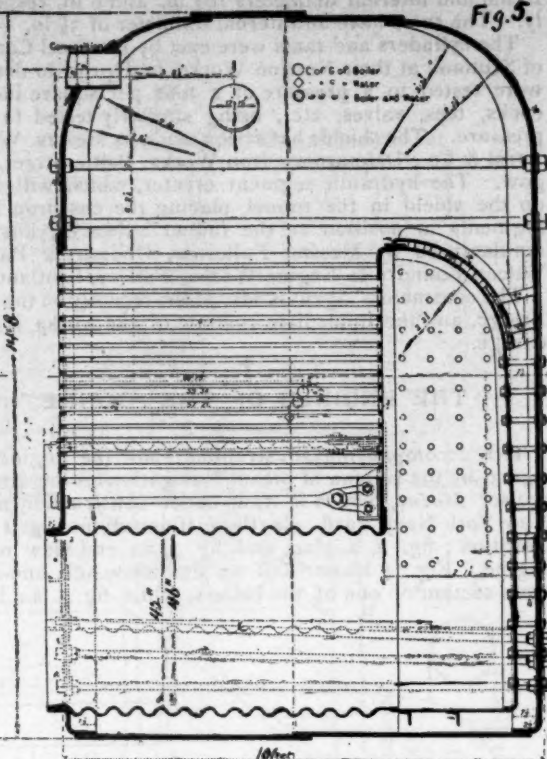


Fig. 8.

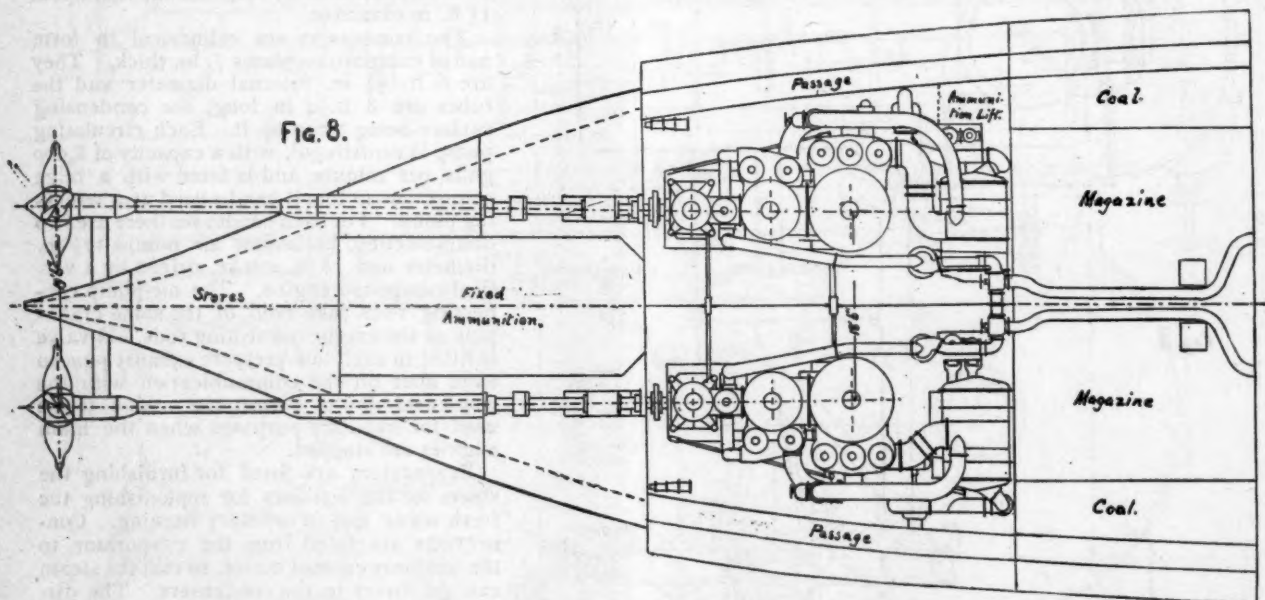


Fig. 6.

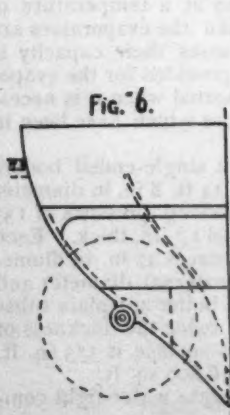
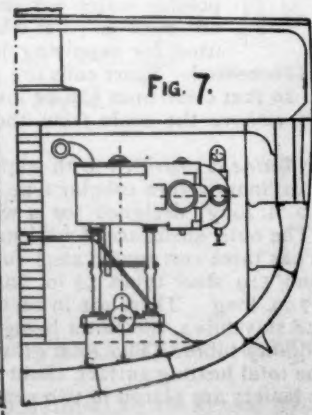


Fig. 7.



partments, four in each, with fore-and-aft fire-rooms. There are two fixed smoke-stacks extending to a height of about 60 ft. above the lower grates. The forced draft is on the closed ash-pit system, the air being led into the ash-pits by ducts under the fire-room floor. The blowers are driven by enclosed three-cylinder engines, and draw the air from the engines and fire-rooms so as to give good ventilation.

The main and auxiliary feed systems are duplicates as to pumps, piping and valves, excepting that the main feed-pump draws water only from the tanks, while the auxiliary pumps can also draw directly from the sea. Provision is made for heating the feed-water.

The auxiliary machinery includes reversing and turning engines, fire, bilge, drainage and flushing pumps, ash-hoists, workshop tools, etc. Besides the steel machinery there is a complete hydraulic plant for operating the turrets and for loading and turning the guns. The working

pressure of this hydraulic plant is 600 lbs. per square inch.

As already noted, the *Maine* is under construction at the New York Navy Yard. The contract for the machinery was awarded to N. F. Palmer, Jr., & Company, of the Quintard Iron Works, New York, for the sum of \$735,000. Work is now well advanced on both ship and engines.

LARGE IRRIGATION CANALS.

(Condensed from a paper read before the Denver Society of Civil Engineers, by G. G. Anderson, C.E.)

THE present paper treats chiefly of the practice which has so far obtained in Northern Colorado, where irrigation was first undertaken, and it may be said that in some of the earlier canals but little engineering skill was applied. There have been in that district three distinct periods of ditch building, which may be classed as the individual, the colony or community, and the corporations periods. In the first are included the small ditches made by the pioneer to irrigate his patch of land. In the second class are the efforts to cultivate the mesas by combined effort, as at Greeley and elsewhere, and in the third the large enterprises which have lately sprung up, and which require an amount of capital which can only be furnished by corporations.

In the case of individual effort it may be said that it leads generally to a faulty system, or rather lack of system, and a great waste of water, as can readily be seen; moreover, it cannot be applied at any considerable distance from the sources of supply on account of the expense. As to the canals of the second period, they were often badly made owing to lack of experience; in some cases their faulty location was due to local circumstances, where, in order to obtain water-rights, it was necessary to buy old ditches, and usually their lines were followed. As to the third or corporate period, many mistakes have been due to too great haste in undertaking the enterprise, and to the fact that in many cases the engineers have been compelled to go to work before acquainting themselves properly with the requirements of the district or with its physical conformation.

It may be said as to construction that there are two general varieties of irrigation enterprise: the first being where it is proposed to limit the use of the canal to the cultivation of a distinct area. In this case the highest elevation would be found and the survey carried back to the proposed source of supply. It would then be necessary to decide upon the grade to be given to the canal and the amount of water required for the district, and from these data to calculate the size of the channel needed.

The second case is where, a natural site having been selected for the head-works, it is proposed to construct a canal outward without any limitations save those of economical construction. In this case the size of the channel would of course depend mainly upon the supply of water available.

In either case the engineer should first make himself thoroughly familiar with the physical conformation of the country to be traversed, the character of the soil being carefully examined with special reference to the grade to be adopted, and in this the grade question is found the first vexatious problem in construction. If the grade chosen is too great, erosion of the banks and scoring of the bed will follow, while if the grade is too light, there will be constant trouble from the deposit of silt. So far as possible the grade should be uniform throughout, and if any change is made it should be increased and never decreased, and for the same reason the velocity should be regulated by the cross-sections of the channel to prevent, in both cases, deposit. The general opinion is that a low velocity—from 3 to 5 ft. per second—is best, although some engineers claim that higher speed is preferable, even if it is necessary to protect the channel.

In the older ditches in Colorado grades were generally established too high, being seldom less than 5 ft. per mile, but in later construction the inclination ranges from 6 in. to 3 ft. per mile. More experiment is needed to establish a reliable formula for determining the relation between velocity and capacity of a canal.

The form of the channel is regulated to a great extent

by local requirements. Trapezoidal forms are now usually adopted, placed deep when the water has to be carried a certain distance, and shallow where it is to be delivered to adjacent lands along the line of the canal. The larger number of canals are on side-hill work calling for the construction of only one bank on the lower side, and in such cases it is economical to set the channel in a cut sufficient to provide material for the bank.

The beds of large canals are usually provided with a sub-grade—that is, the bottom is sloped from the sides to the center to a depth of from 1 to 3 ft. While the superiority of this form is not generally admitted, the writer's experience is largely in its favor as tending to keep the current in the center of the channel.

The provision of a berme 5 or 6 ft. from the edge of the excavation to the toe of the artificial bank is also advantageous. Large canals are seldom called upon to carry their full capacity for a year or two after their construction, and in such a case the water can be confined by the berme to the excavated part of the channel, giving the artificial bank time to settle and solidify. It is scarcely necessary to say that the construction of flumes should be avoided wherever possible, as they are expensive both to build and to maintain; but they are necessary in certain cases and may sometimes be economical, as where the ground is composed either of very hard or very porous or shattered material. Most flumes in Colorado are of timber; but unfortunately the native lumber of the region is poorly adapted to this class of work, while the sudden changes in the climate renders decay very rapid, so that the average life of the flume does not exceed eight years. It is, however, a financial question, and as long as timber is cheaper than any other material, it will probably continue to be used. The question frequently arises with regard to the construction of flumes, should the grade be altered in any way from that of the canal proper? Experience suggests that if altered it should be increased, even if it is necessary to protect the approach embankments from erosion in order to insure the rapid delivery of water and the avoidance of dead weight on the structure.

Too much importance cannot be attached to the necessity of securing good alignment, and one of the worst features of practice so far has been the use of very sharp curves in large canals. It must be remembered that badly arranged curvature diminishes the delivering capacity of a canal very seriously.

As to the maintenance of canals, the most serious feature is the removal of silt. In some of the canals on the lower districts of the Platte River country, the annual expense under this head is large, and if the canal is poorly constructed it is very apt to have its capacity seriously reduced by deposits. There are various methods which may be employed to prevent deposit. The first is to so arrange the head-works that the water will enter the canal as clear as possible. At the head-works of the High Line Canal, for instance, the dam was built 14 ft. above the bed of the river. Waste-gates on the west side of the river, over 150 ft. from the head-gates of the canal, are 2 ft. below the level of these main gates. The effect of the dam, in the first place, is to form a settling pond, and by always keeping the waste-gates slightly open it is possible to carry a large proportion of the silt into the river below. In addition to this, at the lower or east end of the channel is another set of waste-gates, immediately below which is a check 2 ft. high across the flumes, over which the water has to pass before entering the canal proper. These gates also are always kept open, and with the further safeguard of putting all irrigation outlets level with the bed of the canal, it has so far been kept comparatively free from deposit.

Another method which is frequently adopted in India is to excavate the first half mile with a base sufficiently large to cause a great diminution of velocity. Silt is deposited during floods and excavated when the canal is closed.

It is necessary to provide against damage to head-works by drifting wood, and in streams carrying much of such material dams should be built with a free overflow, affording no obstacle upon which the drift can collect. In Colorado the streams are generally subject to sudden fluctuations, so that the use of planks or similar devices to raise

the water at will is dangerous. Probably the best plan is the use of a floating boom to prevent timber from dragging and lodging against the dam.

In maintaining flumes the great question is the prevention of leakage, and it is generally necessary to overhaul them and caulk the cracks with oakum before opening the canal in the spring. In cases where, from any cause, the flume is left dry in summer, serious leakage will result, causing loss of water at a time when it is precious; to provide against such contingencies the only course seems to be to use double floors laid so as to break joints, and thoroughly coated with tar.

To prevent damage from the erosion of the banks and the scoring of the bed affords a wide scope to the ingenuity of the engineer. Of course much depends upon what material can be obtained most cheaply. In some cases where slag could be readily had it has been found a very excellent material. Mattresses of willow slips in the face of the bank have also been found useful, but diminish the free flow. The scoring of the bed can only be overcome by the use of rock or timber checks.

A formidable difficulty in maintaining a large canal is the making provision for storm water; this is particularly the case with a canal on a side-hill, which intercepts the drainage from higher lands, and here it may be said is one advantage in low velocities and grades, since a large body of water is troublesome enough to handle without increasing its impetuosity by giving it a high velocity. Waste-ways must be provided at the best natural sites, and there must be constant watchfulness. Flumes should be provided with waste-gates sufficient to discharge at will one-half the capacity of the canal, and where natural water-ways are crossed by embankments, flumes for waste should be made at either end and sufficiently far from the embankment to prevent waste water from injuring it. The construction of timber waste-ways in the center of embankments is not to be recommended, as it will certainly destroy the embankment. Waste-gates upon flumes are usually constructed on the sides, and it may be found that in such a position they are not adequate for the purpose of withdrawing large bodies of water. The quickest method of emptying a flume is from the bottom, and this plan should be adopted if possible. Automatic gates have been tried, but are generally out of order when wanted.

Damage to flumes by floods in creeks and water-ways crossed by them may often be prevented by careful observation of the locality and by changing direction of the stream.

The cost of maintenance of a large canal will vary with the excellence of the original construction, with the topography of the country and many other considerations. A California estimate is \$400 a mile, including all repairs, but in practice in Colorado the amount has varied from \$150 to \$400 a mile.

In operation a large canal should be arranged in divisions, each under a superintendent or, as he is called in Colorado, a "ditch-rider." The length of these divisions will depend upon the number of outlets and the character of the work, but it should be so regulated that the superintendent can visit over part of his division daily; and he should make a daily report. It is important that the engineer in charge should be informed daily of the quantity of water entering the canal and the quantity attainable from the source of supply.

The question of how best to distribute water over a district is a very important one; while more or less skill has been devoted to the construction of the main canal, the laterals have been left very largely to the cultivator, and to this fact, more than is usually conceived, is attributable a large amount of the trouble and annoyance created over the otherwise sufficiently troublesome question of distribution. To say nothing whatever about the judicious or injudicious construction of the subsidiary channels, though it has as much bearing on the question as the construction of the main canal, while the distribution of water from the main canal is attended by at least some attempt at regulation, it is very rarely indeed that there is any such upon laterals. The absence of such regulation increases a hundredfold all the natural difficulties surrounding proper distribution, and urgent consideration of the question in

practical form should be undertaken by the cultivator, whose interests are bound up in it. Very considerable objection has been manifested to the system of distributing water by the acre or the crop, and it is doubtless true that whenever comparisons have been made of the duty of water under these systems and under the distribution by quantity they have been favorable to the latter. It has not been possible, from an operative point of view, to successfully introduce the latter system in Colorado, partly for reasons outlined in the foregoing remarks; and though canal companies have been condemned for stopping the way of this improvement in the economical use of water, it is fairly presumable that they will welcome the adoption of a system so largely to their financial interests, if they can be assured of the reasonable possibility of its introduction, particularly should it tend to lessen the constant friction between the individual consumers and between them collectively and the canal company. At present it does not seem possible to adopt either the horary system or the rotation system in canals. The latter, one may conclude, is capable of successful application only in canals with very large capacities and almost always certain of supply. It is applied in India, where some of the canals carry as high as 5,000 cubic feet per second. With such a supply it is possible to conceive of one canal being supplied with water for one day only in two weeks, and distributing it with good practical results. Under ordinary circumstances in Colorado one day's run of full capacity in a 50-mile canal would barely give any water at the lower end.

The horary system can probably be applied on similar conditions, certainly as regards the supply. In Colorado it may be concluded that the value of water is not yet rated sufficiently high to permit of the successful application of the system.

There is still lacking in Colorado a simple and easily understood method of measurement and a definite unit of measurement. The gauge which was known as the "Max Clarke Gauge," and the Foote system have both been used, but neither of these is adapted for large canals. The method gaining in favor, in spite of some drawbacks, is the sharp-edged weir, the Francis formula being adopted. Where this is used the depth of water on the weir should not exceed one-third of its length; the depth in the chamber before the weir should be at least three times that on the weir, and the tail-water should not be allowed to rise higher than 6 in. under the head of the weir plate. It is not always possible to obtain these conditions, owing to the imperfections of the lateral channels, and there is the further disadvantage of loss of head, preventing the utilization of lands close to the canal.

In Colorado the inch system of measurement of water supplied is enforced by law, but the cubic foot per second, although not generally recognized, is really the correct system. The inch system is practically obsolete, and will be finally displaced.

In regard to the duty of water, it may be said, in the first place, that it is difficult to lay down any rule in regard to it. The same soil will be affected differently in various climates; differing soils will require differing duties in the same climate, and different crops need different quantities of water. The duty of water is also largely affected by local requirements and practices, such as have been already referred to, and being so it cannot be said that the duty in Colorado should be the same as in Spain or India. If the duty of water in one place is five times less than in another, it raises the presumption that the duty is small and might be increased. Probably the smallest duty of water known is in the Valencia plains, where it is at the rate of 35 acres per cubic foot per second, but that is in the rice cultivation. On the same plains in general crops the duty reached 101 acres per cubic foot. In Granada, where water was scarce, it reached 286 acres per cubic foot, and in Elche and Lorca still higher duties were obtained; in the former one cubic foot did duty for 1072 acres, and the latter gave the enormous duty of 2200 acres. In India a duty of 240 acres on the Ganges Canal was obtained, while it reached 250 acres on the Eastern Jumna Canal. In short, the duty obtainable out of water was very much a question of the quantity of water disposable. In the older canals of Colorado, a duty was established of

554 acres per cubic foot per second. In later enterprises, it has been the effort to reduce it, to give at least 100 acres per cubic foot, and Mr. Maxwell, the State Engineer, is authority for the statement that the duty can be made 320 acres per cubic foot.

The great purpose of an irrigation enterprise is to endeavor to extend the service of the water to the maximum acreage, and in spite of the present low duty of water and the difficulties that have been met in the past few years in the great scarcity of supply, which ought to have been of great service to those willing to benefit by experience in an effort to increase it, it is not too much to hope that a gradual increase of duty will be speedily obtained.

Other questions relating to irrigation—such as sub-irrigation, damages accompanying irrigation and the legislation affecting the whole subject—cannot well be treated in a single paper. The necessity for proper legislation is very great, however, as the risk in enterprises of this kind is sufficiently great without further burden of unjust and oppressive laws, and the law should be put in such shape as to be readily understood by all concerned.

In Colorado, as in most other irrigation countries, the necessity of carrying on works of drainage and irrigation simultaneously is being impressed upon practical men more and more every year. Although it is a rare occurrence when these works are successfully conducted together, it is regrettable to note the large and yearly increasing area of low-lying lands going to waste, and which are, during the irrigation season, stagnant swamps, breeding disease. The frequency of typhoid fever and other epidemics in the fall of the year is doubtless due to this cause, so that, from a sanitary point of view at least, drainage must be speedily undertaken. On the other hand, on this matter of drainage the necessity of providing for the storage of water for the lands drained must not be lost sight of. It has been the experience of countries where, during wet seasons, great efforts have been made to carry off the water by drainage, that, in dry seasons, crops have been seriously affected by the lack of proper provision for storage of water.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.

VIII. METHOD OF PURCHASING OILS.

By C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(Copyright, 1889, by C. B. Dudley and F. N. Pease.)

(Continued from page 272.)

FOR the sake of completeness in the discussion of lubricants and burning oils, this article will be devoted to the question of how oils are bought, and to a discussion of hot boxes and hot box and lubricating greases.

It was formerly the custom with lubricating and burning oils to buy by measure, and measure was also used in distributing the oils for use in the service. This practice has been largely abandoned, it having been found that weight is not only a much more expeditious way of getting at the results, but also a more accurate one. If oils are bought by measure, with no check on the shipment, the

number of gallons being stamped on the barrels by the manufacturer or shipper, there is a very wide chance for practices which are hardly to be recommended. At one time on the Pennsylvania Railroad a number of shipments of oil from a certain party were weighed, and the barrels emptied and the tare taken. On checking up the weights it was found that the barrels were universally from one to two gallons short. Indeed there was enough difference in the amount of oil charged for and the actual amount received to enable the party to bid from half a cent to a cent lower per gallon than those who gave full quantity. In the large amount of oil used by the Pennsylvania Railroad, the loss due to this practice amounted in one month to as much as \$250 on one kind of oil, and at one place where the oil is received. This led to a change in practice, and now all oils are bought by weight, which method gives a very quick and efficient way of checking up a shipment, as will be seen by studying the circulars given below. When this practice was inaugurated, a circular was distributed by the Purchasing Department, informing the manufacturers what would be required in future in regard to shipments. This circular is as follows:

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

Purchase of Oil by Weight.

From this date, all materials used as lubricants and burning oils will be purchased by weight, and quotations of prices and bills must be by the pound. In quoting prices, cents and hundredths should be used. A separate bill must be rendered for every shipment, however small, even though it be but a portion of the whole order, and the bill must be sent as soon as possible after the shipment is made.

Every package containing lubricants and burning oils must be plainly marked with the gross weight and the tare. This applies to oil tank cars as well as to barrels. Parties failing to mark both gross and tare on their packages must accept the Company's weights without question.

Whenever a shipment of any lubricant or burning oil is received at any point, it will be immediately weighed, and where practicable will be at once emptied, and the empty packages weighed. If not practicable to empty all the packages, 5 per cent. of the shipment will be emptied and the tares taken. The tares of the whole shipment will then be adjusted in accordance with the weight of the 5 per cent. If the net weight found from above data is less than the amount charged for in the bill by more than 1 per cent., a deduction will be made from the bill equal to the amount of the deficiency over 1 per cent. This 1 per cent. covers leakages in transit, and the amount which adheres to the barrels in emptying; also, possible slight differences in scales.

THEODORE N. ELY,

General Superintendent Motive Power.

Office of the General Superintendent Motive Power, Altoona, Pa., October 1, 1885.

It took a little time for those who were accustomed to think of the price of oil in gallons to learn to compare prices by the pound, but this difficulty soon disappeared. It will be observed that the circular calls for a bill for each shipment, although the whole order may not be filled. The object of this was to enable the adjustment mentioned at the latter part of the circular to be made as soon as possible after the shipment was received. This method described in the circular, so far as the manufacturers and shippers are concerned, has worked very satisfactorily, and we have yet to learn of any disputes and difficulties having arisen in regard to it.

The system of buying by weight would have been incomplete without the information necessary to enable the bills to be checked up accurately being in the hands of the men, and accordingly a circular was issued to the men, giving them all the necessary information on this point. Also, at the same time this circular was issued, it was decided to dispense the oil to the service in small amounts by weight—that is to say, each engineman received a certain amount of burning oil, cylinder lubricant, and engine oil for the trip; also other branches of the service, especially where hand lanterns are required, must have an oil supply. Before the circular below was issued, this had always been done in gallons or quarts, and when the change to giving out the oil by weight was proposed, it met with some op-

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, is on the Work of the Chemist on a Railroad; No. II, in the January number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION of special value in indicating the true character of the materials they must use and buy.

position from those in charge of the oil houses on the ground that it would take too long to weigh. A direct experiment on this point, however, proved that with an ordinary spring balance, the necessary supplies of oil could be given to 20 enginemen in about half the time by weight that it could by measure. The process is excessively simple. An engineman brings his can, containing possibly a little left over from the previous trip, and wants, we will say, five quarts of engine oil. To supply this by measure would necessitate using a gallon measure and a quart measure. To supply this by weight simply necessitates hanging the can on the spring balance, with a funnel in it, and noting the weight. Then add 9 lbs. and 5 ounces of oil, which would be indicated by simply adding that figure to the weight of the can and funnel, as it hung on the balance. In a very short time, as soon as the enginemen began to call for so many pounds of oil, the system of distributing by weight came into great favor, and has been followed with great success.

The following circular gives the information needed by the men in order to start such a system on a railroad:

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

Instructions in Regard to Weight of Lubricants and Burning Oils.

All materials for lubricants and burning oils will, on and after October 1 next, be purchased and used by weight, and all requisitions for any of these materials, for purchases to be made on or after that date, must call for so many pounds instead of so many gallons or barrels as heretofore. The following are approximately the weights per gallon of different kinds of oil:

Lard oil, tallow oil, neat's-foot oil, bone oil, colza oil, mustard-seed oil, rape-seed oil, paraffine oil, 500° fire-test oil, engine oil, and cylinder lubricant, 7½ lbs. per gallon.

Well oil and passenger car oil, 7.4 lbs. per gallon. Navy sperm oil, 7.2 lbs. per gallon. Signal oil, 7.1 lbs. per gallon; 300° burning oil, 6.9 lbs. per gallon; and 150° burning oil, 6.6 lbs. per gallon.

The number of gallons of oil needed having been decided upon, the weight which should be called for by requisition is found by multiplying the number of gallons by the proper weight given above.

All parties furnishing lubricants and burning oils are required to mark each package with both gross weight and tare, but it is not sufficient to simply take these figures off the barrels and compare them with the bills. Every shipment of every kind of lubricants and burning oils must, as soon as received, be carefully weighed. This applies to tallow and greases, as well as all the oils used for lubrication and burning, and must be done whether the oil is subsequently emptied or not.

Wherever possible all lubricants and burning oils must be emptied at once, and the empty packages carefully weighed. In emptying, care should be taken to get all the material out of the packages. With tallow and grease, and with lard oil in the winter, this is especially requisite, and it will probably be necessary to steam out the packages.

Wherever material is shipped to other shops in the original packages, or where it is impracticable to empty them all, at least 5 per cent. of each shipment must be emptied and the empty packages weighed, the tares for the remainder of the shipment being taken from the packages themselves. If the weights of the packages, which are emptied, correspond with the marked tares, no adjustment is necessary. If they do not correspond, the tares for the whole shipment must be adjusted in accordance with the tares of the 5 per cent. which were actually weighed.

The gross weights and tares having been obtained, the net weights will appear. If the sum of the net weights thus obtained is not over 1 per cent. less than the amount charged for in the bill, the Form C may be signed in the usual way. If the deficiency is more than 1 per cent. of the amount charged for in the bill, a statement of the deficiency, together with the Form C, unsigned, should be sent to the Superintendent of Motive Power for adjustment and correction.

THEODORE N. ELY,

General Superintendent Motive Power.

Office of the General Superintendent Motive Power, Altoona, Pa., September 12, 1885.

In regard to the above circular, the weights given for the different kinds of oil are sufficiently close to accuracy, so that no serious trouble occurs in adjusting. Moreover, the

system of buying by weight eliminates all questions of capacity. The words "Form C," in the circular, are the technical words by which the duplicate bill which goes into the hands of the party receiving the material is known.

IX.—HOT BOX AND LUBRICATING GREASES.

Perhaps no subject connected with the operation of railroads causes more annoyance, not only to the public but also to the operating officers, than what are known popularly as "hot boxes." In reality it is the journal and bearing which get hot, and not the box which encloses them, and carries the waste and lubricant. Much delay of trains and annoyance in every way is occasioned by these failures of the journal and bearing to run cool, and many speculations have been indulged in as to what the cause of hot boxes, using the technical term, is, and what is the best cure. Probably not less than 50 or 60 different compounds to be used in treating hot boxes have been analyzed and examined in the Pennsylvania Railroad Laboratory during the last 15 years. These substances are known under the general name of hot-box greases, and are to be carefully distinguished from greases offered for lubrication. The lubricating greases are not supposed to be used as a cure for a hot box, but in place of oil as lubricant on certain high-speed trains. On the other hand, hot-box greases are used only when the journal and bearing get hot in service.

Upon the general question of using grease in place of oil as car lubricant, our opinion, based on a number of years' experience now, is that, all things considered, oil is far the best lubricant. It would take a careful analysis, however, of all the points involved in lubrication to make clear the basis on which this opinion rests, and it is possible later on, in this series of articles, the question of lubrication may be discussed in full. For the present it is sufficient for our purpose to say, that in all cases where the pressures do not exceed 350 lbs. per square inch of projected area on the journal, and where the speeds do not exceed 30 or 35 miles an hour average, oils are altogether the best lubricants, provided proper attention and care is given to the car boxes. On the other hand, where the pressures may reach 400 or 450 lbs. per square inch, and where the speeds run from 35 to 50 miles per hour, something a little more viscous seems to give rather better results, and consequently in modern practice, especially where high speeds are employed, there is a tendency toward the use of grease in place of oil. So far as the Pennsylvania Railroad goes, however, this tendency must be regarded as still in the experimental stage. We do not think there is anywhere in existence information which shows positively that under the same care less difficulty is experienced even with high-speed trains, which are lubricated by means of grease, than with the same trains lubricated by a good oil. However, as stated above, there is in the conditions affecting the success of the lubricant a plausible basis for the use of a little more viscous material, where high speeds and high pressures are involved, than where lower speeds and less pressures prevail, and consequently, as has already been stated, there seems to be a disposition toward the use of lubricating greases on certain trains.

The lubricating greases which we have examined have in almost every case contained more or less petroleum product as a large constituent, the petroleum product being hardened or made more viscous by the addition of tallow, lard oil, or neat's-foot oil, and in some cases by the use of some of the vegetable waxes, such as japan or carnauba wax. Also in an experimental way the petroleum products have been mixed with rosin somewhat as a means of getting a lubricant which would hold up the load a little better, and, owing to greater viscosity, have a trifle greater power of staying between the surfaces. The question of lubricating greases, however, is so unsettled that we would hardly be able to give a formula for a good lubricating grease.

Upon the question of hot-box greases there is much more information, but before we speak on this point, it might be well to devote a few words to the causes of hot boxes. Popularly among the men, the oil or lubricant used is supposed to be the cause of many of the hot boxes. Frequently the bearing metal is supposed to be at fault, some-

times the waste is blamed, and much more rarely lack of care, or lack of lubrication, or bad fitting of journal and bearing are blamed with the difficulty. To those who are not familiar with the method of lubricating car journals, it may perhaps be well to say that the bearing which holds the weight of the car rests on top of the journal, covering about three-quarters of its diameter; that surrounding both bearing and journal is the cast iron-box which rests on top of the bearing, and has considerable open space below the journal, which open space is filled with wool waste or mixed wool and cotton waste saturated with the lubricant. This box is made as close as possible behind, and fitted with what is known as a dust guard, which encloses the journal as tightly as possible on the back side. On the front side the box is opened by a lid, and the condition of the waste is examined at each inspection point, being stirred up if necessary, and fresh lubricant added. By this method of lubrication, as will be seen, the journal is dependent for the lubricant that it gets from the waste on touching the waste, and among the causes which are sometimes given for hot boxes is, "Waste too far from the journal."

Turning now to the cause of hot boxes, our own view, based on the experience and observation of a number of years, is that there may be a number of causes producing a hot box. With the lubricant in common use on freight cars, a pressure above 350 or 400 lbs. per square inch on the bearing is quite apt to lead to a hot box, due simply to over-pressure, the lubricant being not sufficiently viscous to hold the surfaces far enough apart to prevent too great interference of the surfaces with each other and consequent generation of too great heat. Again, it not infrequently happens that journals and bearings must be used which do not fit each other, as when a new bearing is put on a worn journal. This causes too high pressures on certain points, with consequent generation of more heat than can be disposed of in the ordinary way. Also it sometimes happens that the journal or bearing may contain slag or mineral matter mechanically enclosed, which causes grinding action and consequently excessive heat. Still again, when new cars go out, the journals and bearings are more or less rough, even with the best appliances for fitting them together in the shop, and consequently until they have worn off the inequalities, and have become adapted to each other, it is not infrequent that hot boxes occur. All these causes are to a certain extent unavoidable concomitants of the service, and hot boxes arising from these causes can really not be regarded as blame-worthy. In our judgment, however, not over 10 per cent. of the hot boxes can be accounted for in this way. By far the principal portion of hot boxes, we think, is a direct result of lack of care, and if our theory is correct, every journal, even though supplied plentifully with lubricant, but sufficiently neglected in other respects will sooner or later run hot. The theory which we use to explain the largest portion of hot boxes is as follows: It is well known that all journals and bearings are subjected to wear, and that the portions which wear off are usually very small bits of metal, which at first simply discolor the oil. It is also well known that no car box has yet been devised which completely excludes the dust from the air. Both of these—namely, the wearings from the journals and bearings, and the dirt from the air—constantly mix with the oil or lubricant used, so that from the first moment when a new journal starts, the oil in the box is becoming more and more a mixture of mineral matter with the lubricant. If now the oil is 90, 80 or 70 per cent. and the mineral matter 10, 20 or 30 per cent. of the material which goes between the surfaces as the journal revolves, it is entirely possible that no difficulty will occur, since such a mixture is a very fair lubricant. On the other hand, as time progresses there is constant change, resulting in an increase of mineral matter, and ultimately the lubricant which goes between the surfaces becomes a mixture of 75 or 80 per cent. perhaps mineral matter and 25 or 20 per cent. of oil. Such a lubricating material is in reality a paste, and with such a lubricating material enormous amounts of heat are generated. In the common language of the shops, the journal is "dry." In actual fact the journal is lubricated with a mixture composed largely of mineral mat-

ter and a small amount of lubricant. The above explanations are based on the supposition that a journal receives no fresh supply of oil and no care, and there is no doubt, we think, but that under these conditions any and every car journal in service will sooner or later get hot. But it will be urged that no journal runs without care and constant supplies of oil added to keep down the percentage of mineral matter in the lubricant. To this we reply, the addition of oil undoubtedly puts off the evil day, and if the oil added would keep the waste clean, very few hot boxes would probably occur. But unfortunately the waste in the car box retains the mineral matter and wearings in the car boxes in spite of everything which can be done, and no amount of oil added will ever keep waste free from accumulations of mineral matter. It results even with the best of care, and constant additions of oil, unless the dirty waste is taken out and its place supplied with fresh clean waste from time to time, that the waste in every car box becomes continually more and more dirty, so that the lubricant which the journal and bearing gets is ultimately so largely composed of mineral matter that excessive heat is generated.

In proof of the theory of hot boxes advanced above, the following experimental data have been obtained. *First*, oil squeezed out of the waste of some car boxes which had been moderately warm was tested on the oil-testing machine, in direct comparison with clean, fresh oil, the amount of heat generated by the two oils, under the same conditions, being determined approximately. The result showed that the dirty oil from the car boxes generated nearly double the amount of heat that was a concomitant of the clean, fresh oil. In other words, the more mineral matter there is in a lubricant which goes between the surfaces, the greater amount of heat will be generated. This experiment can be repeated any time by any one who has the appliances, and it was repeated by us with various modifications, graphite, tripoli, and other mineral substances being purposely added to the oil, to get some idea of the relative amount of heat generated with each of these different substances as lubricant. These experiments are hardly in sufficient shape to warrant publication as conclusive results, but upon the main fact—namely, that with dirty oil more heat is generated than with clean oil, there seems to be no doubt. Moreover, this difficulty in regard to heat with dirty oil seems to be cumulative—that is to say, the warmer the journal using dirty oil gets, the more limpid the oil becomes, and the less there is of it between the surfaces, thus causing the mineral matter to be more and more continually an element in the lubrication; and, as every practical mechanic knows, when the lubricant becomes largely mineral matter, or, in technical language, the journal is "dry," very great friction results, with consequent great generation of heat.

Second, at one time, either in December or January, on a certain railroad, there was a very serious epidemic of hot boxes, so much so as to cause real difficulty with the traffic, and a very careful investigation was made as to the cause. It was finally found that during the months of September and October previous, the traffic had been so heavy that the car inspectors were not able to repack the ordinary number of cars per day with fresh waste, and that even up to the time when the epidemic occurred they had not been able to catch up. The consequence was that the car boxes were actually running on dirty waste, and although the normal amount of oil had been constantly used, the epidemic of hot boxes had resulted as above stated. A little additional force put on, and a repacking with fresh waste of quite a percentage of the equipment, caused the epidemic to disappear.

Third, on a certain railroad which runs through a very sandy country, and which, at certain seasons of the year, has a great traffic, there was great difficulty from hot boxes, due, apparently, to sand and dirt getting into the boxes. A piece of pasteboard laid in under the car box lid, over the waste, caused this epidemic to disappear. This piece of pasteboard fitted moderately tight around the edges of the box under the cover, and at the end of the run would be found covered with sand. Care being taken to throw this sand out when inspecting the boxes, no greater difficulty was experienced on this road than on others with hot boxes.

If the reasoning above is correct, it seems to follow that a large portion at least of hot boxes result from lack of sufficient care and attention to the boxes. If the waste is renewed with sufficient frequency, good appliances made use of to keep the dirt out, and a good fair lubricant used, it would seem that hot boxes might be reduced to a very small number, and we really do not know of anything which can be done that will take the place of this care and attention. Until some method of car lubrication is devised which does away with the waste, there is very little possibility of keeping the number of hot boxes to a minimum, without a good deal of expense and labor in the matter of the renewal of waste, and care of the boxes in service.

A journal and bearing having become very hot, what is the best remedy? The answers to this question are very numerous. With some the use of tallow alone is believed to be very efficacious, and we think there is no doubt that many hot boxes can be cured by the use of tallow, or indeed a car candle laid in alongside of the car journal. Others have their favorite remedy in some form of hot-box grease, which is supposed to have the power of cooling the journal if it is only put in the box, however hot the journal may be. No hot-box grease that has ever been tried, however, so far as the experience of the Pennsylvania Railroad goes, will make this claim good. Greases have been tried which cool off a fair portion of the boxes to which they are applied, but no grease which we have tried will universally cause the box to run cool after it has once become hot. The general theory on which hot-box greases are constructed is apparently to make them of such lubricating materials as will stand very high temperatures without vaporizing, and as will give a product more viscous than the oil which was in the boxes before. In our analyses of hot-box greases we have found high fire-test petroleum as an almost universal constituent. In addition to this some of them contain soaps of various kinds, lime soap being a favorite one; sometimes soda soap is a constituent, sometimes North Carolina tar is a constituent, almost always water to a greater or less extent; sometimes tallow, lard oil, neat's-foot oil, cotton-seed oil, or some other saponifiable fat, and in most cases mineral matter, either soapstone, graphite, whiting or mica. Sharp sand is also not a rare constituent, apparently not introduced on purpose, but due to carelessness in manufacture. Sulphur also frequently occurs as a constituent, and some greases which have been highly lauded as absolute cures for hot-boxes are apparently nothing but sulphur and fats. Rosin and rosin oil are sometimes used. The number of hot-box greases in the market is legion, and it is a very poor month which does not bring out from one to two new greases. We are free to confess we do not know of any grease in the market that is perfectly satisfactory.

It will be seen from what has preceded that we are strongly of the opinion that the number of hot boxes in service can be made very small by sufficient care and expense, and if this is true, the best antidote to hot boxes would seem to be to furnish the requisite care and attention. On the other hand, it will be noted that there seems to be some causes for hot boxes which are practically uncontrollable under the ordinary conditions of service, and for these hot boxes some remedy must be devised. Unquestionably if a car, the boxes of which have become hot, can be taken out of service, the boxes allowed to cool, the journals and bearings refitted and repacked with clean waste and oil, very little difficulty would be experienced with it; but this is not a possibility in the ordinary management of the service, especially the freight service. The great desideratum is some material which can be put into a box that has once become hot while it is hot, causing a few minutes' delay to treat the box, and then allowing the car to go ahead. For this purpose undoubtedly a good grease is the best thing known at present.

Our ideas as to what a hot-box grease should be may be stated something as follows:

First, it should contain no mineral matter whatever. We are quite well aware that upon this point there is a very broad difference of opinion even among experts, some claiming that after a box has become hot, especially if the bearing and journal have become scored or scratched,

a little mineral matter with some lubricant serves to wear the surfaces smooth much sooner than would otherwise result. Our own view is that the addition of the mineral matter is simply laying the foundation for another hot box sooner or later, and although it works all right while the viscous lubricant which is a constituent of the grease is present, as soon as this viscous lubricant has been carried out of the box by subsequent additions of oil, the mineral matter stays to be the cause of difficulty a second time. The most experienced inspectors on the road usually prefer a grease with a little mineral matter in it, but those who are best observers claim that as soon as the box becomes cool all the grease that can be gotten hold of should be taken out of the box and thrown away. In the freight service this is impossible, and also it is very nearly impossible in the passenger service, so that we prefer to do without the possible benefit of the mineral matter in the grease while the box is cooling off, to having the resulting difficulty of the mineral matter being in the box. Moreover, definite trials have been made of greases containing no mineral matter, rather better results being obtained than with grease containing mineral matter, so that we do not know of any positive experimental data which prove that mineral matter is a valuable constituent of hot-box grease.

Second, a good hot-box grease should contain something to carry off heat. For this purpose undoubtedly water is the best substance known, and we see no reason why a good hot-box grease should not have from 20 to 30 per cent. of its weight of water as an essential constituent.

Third, after the water has evaporated it should leave a material which has a tendency to adhere to the hot surface, and which is a fairly viscous lubricant at high temperatures. Upon this point it will be noted that one of the causes given above for hot boxes is too great interference of the surfaces with each other, and this is especially true of journals and bearings after they have become somewhat scratched. If now a lubricant is used which will hold the surfaces a little farther apart, and render the interference of the surfaces a little less, much less heat will be generated, and consequently the box will have time to cool off. Most of the greases in the market fill one of these requirements fairly well—namely, they have a tendency to hold the surfaces further apart, because they are rather dense viscous substances. The adhesiveness at high temperatures is not so easy to obtain, and many of the greases of the market seem to be almost repelled by the hot surfaces.

Fourth, a hot-box grease should contain nothing that does not ultimately dissolve in the oil added afterward as lubricant. The reason for this is obvious. The grease is only added for a certain purpose, and it is not at all the best lubricant for steady use. Owing to the impossibility mentioned above of removing the grease after it has accomplished its work, we deem it an essential, therefore, that the grease should dissolve readily in the oil subsequently added to the car box. We really do not know of any grease in the market that fills this requirement. Obviously the mineral matter under no circumstances dissolves in the oil added, and a good many of the other constituents mentioned above as characteristic of hot-box greases in the market do not dissolve in oil.

Experiments are in progress on the Pennsylvania Railroad with various greases, which approximate the conditions mentioned above, and thus far the results seem very favorable. The usual method of treating hot-box greases is to take a barrel of the grease at some inspection point, and treat every hot box that comes along to that point on freight trains with a proper amount of the grease. The box is then allowed to go ahead, even though it may be more or less hot when it starts. A record is kept, and 35 or 40 miles from this place an observation is made as to whether the box is cooled off or not under this treatment. Usually an experiment embraces 100 hot boxes, and the results obtained show that with different greases, all the way from 50 to 75 or 80 per cent. of the boxes treated are cooled off.

There is much need of study on a method of car lubrication. The "waste method," if it may be so called, is defective in many respects, and the man who will devise a

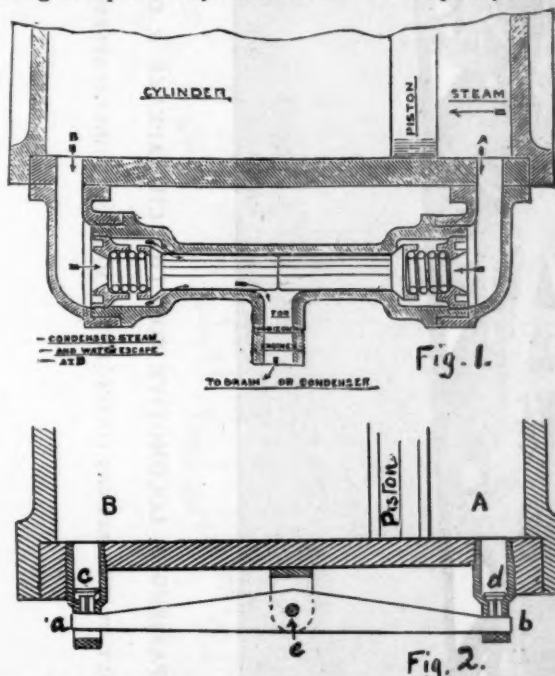
successful and at the same time simple method of car box lubrication that does away with the waste will not only prove a great benefit to the railroad world, but will also have a good show of securing substantial reward.

The next article of the series will treat of battery materials, including zinc, sal ammoniac and sulphate of copper.

(TO BE CONTINUED.)

AUTOMATIC BACK-PRESSURE RELIEF VALVE.

A LATE number of the *Engineer* contains the following engraving and description of a relief valve, which may interest some of our readers, as a similar scheme has been tested in this country some years ago. Our contemporary says: "The accompanying engraving, fig. 1, illustrates a new combined drain cock and relief valve, patented by Mr. W. Wood, Summerfield-crescent, Birmingham. The engraving shows the valve at work. The steam entering the cylinder at *A* closes the valve at that end, at the same time opening the opposite end *B*, and *vice versa* with the motion of the piston, allowing any water that may accumulate in the cylinder to pass out into the drain. The valve is always open in the same direction that the piston is traveling, which prevents accidents through priming, or neglecting to open the cylinder cocks. Its simplicity of con-



struction renders it impossible to get out of working order—it is made of hard gun-metal. The advantages claimed are: (1) It dispenses with the two ordinary cylinder cocks now in use, which leak or become corroded; (2) the water is automatically taken away, as it accumulates in the cylinder; (3) the valve is always open when the engine is standing, and thereby prevents accident when starting through neglect in opening the ordinary cocks; (4) any back-pressure caused by the steam passing the piston, or water introduced by priming, finds instant relief, thereby dispensing with relief valves in the ends of the cylinder, and reducing the breaking of joints to a minimum; (5) it is perfectly automatic and direct-acting.

About 30 years ago Mr. William Buchanan tested a similar device on the Hudson River Railroad. Fig. 2 is a drawing, made from memory, of the device he used. It consisted of two conical valves *c* and *d*, at the ends of the cylinder. These valves rested on the ends of a lever *a b*, which was pivoted at *c*. When steam was admitted into the cylinder at *A* it pressed the valve down on its seat and closed it. At the same time it depressed the end *b* of the lever and raised up the opposite end *a* and the valve *c* and opened it. The reverse operation occurred when steam was admitted at the opposite end *B* of the cylinder.

The interesting result was that when this device was ap-

plied to the locomotive, it was found that it thumped badly, and, as Mr. Buchanan reports, nearly hammered itself to pieces. The engine with this device on it did not run nearly as well as it did before, and would not make either time or steam. It was a practical exemplification of the value of compression to the successful working of a locomotive.

UNITED STATES NAVAL PROGRESS.

THE new gunboat *Bennington* was launched at the Roach Yard in Chester, Pa., June 4. The *Bennington* is 230 ft. long, 36 ft. beam and 1,700 tons displacement. She has twin screws, driven by two triple-expansion engines, with cylinders 22 in., 31 in. and 50 in. in diameter and 30 in. stroke. She will carry six 6-in. breech-loading rifled guns, eight small rapid-fire guns and eight torpedo-tubes. The *Bennington* is in all respects like the *Concord*, which was described and illustrated in the April number of the JOURNAL, page 168.

Bids were received at the Navy Department in Washington, June 10, for three new ships. The first and largest—which is the largest vessel yet designed for the Navy—was the armored cruiser, No. 2, of 8,100 tons displacement, a description of which was given in the April number of the JOURNAL. For this ship five bids were received, as follows:

The William Cramp & Sons Ship & Engine Building Company of Philadelphia, on the plans and specifications of the Navy Department, \$3,150,000; on plans and specifications submitted by themselves, \$2,985,000.

The Union Iron Works, San Francisco, on the Department plans, \$3,100,000; on their own plans as submitted, \$3,000,000.

The Risdon Iron & Locomotive Works, San Francisco, on the Department plans, \$3,450,000. This company has never done any naval work. The appropriation limit for the ship is \$3,500,000.

The second ship is officially designated as cruiser No. 6, and is a protected cruiser of 5,500 tons displacement. This ship was described in the June number of the JOURNAL, and will be of the same type as the *Baltimore*, *Philadelphia*, *Newark* and *San Francisco*, but larger, having about 1,000 tons more displacement. For this vessel only two bids were received, both from the Union Iron Works, San Francisco, who offered to construct the ship on the Department plans and specifications for \$1,796,000, or, according to their own plans, for \$1,760,000. The appropriation limit for this ship is \$1,800,000.

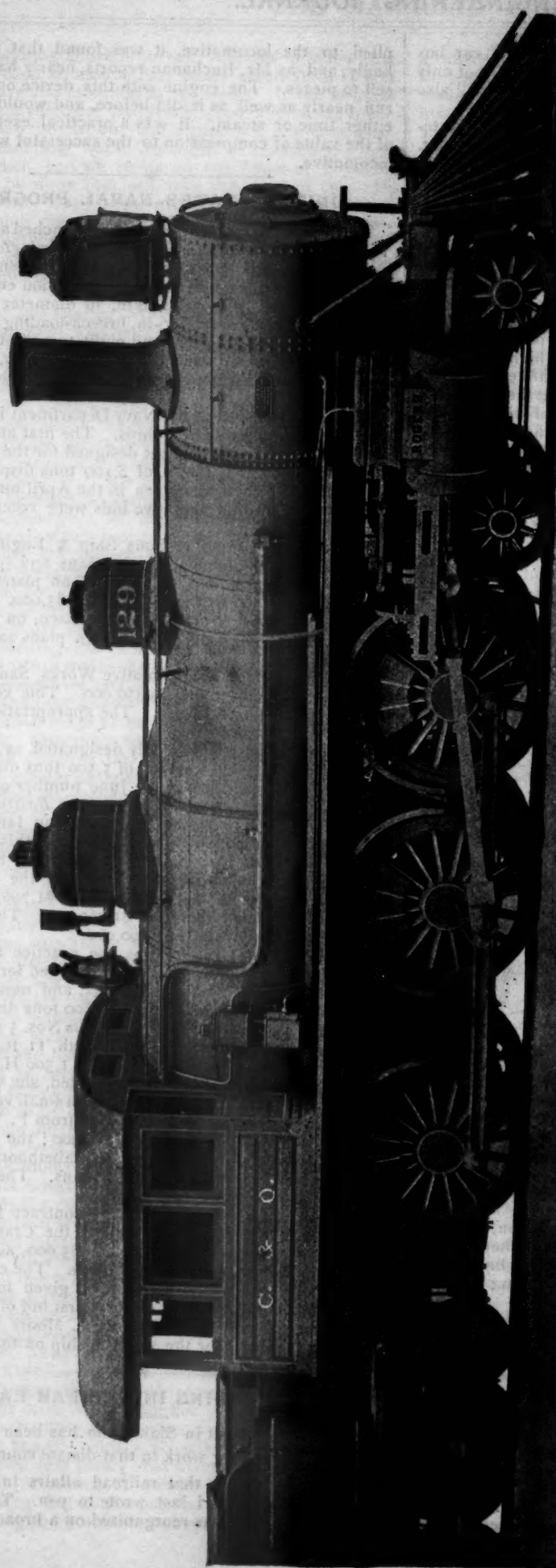
The third vessel bid for was the practice ship for the Naval Academy. Bids had been received for this vessel previously, but no contract was let, and new bids were called for. This is a small ship of 800 tons displacement, and of very similar type to the gunboats Nos. 5 and 6. She will be 180 ft. in length, 32 ft. breadth, 11 ft. 6 in. mean draft, with triple-expansion engines of 1,300 H. P. Owing to the purpose for which she is intended, she will have an unusual amount of work upon her for a small vessel. Two bids were received for this ship: one from F. W. Wheeler of West Bay City, Mich., for \$245,000; the other from Samuel L. Moore & Company of Elizabethport, N. J., for \$250,000, both on the Department plans. The appropriation limit is \$260,000.

The Department has awarded the contract for armored cruiser No. 2 (the 8,100-ton ship) to the Cramp & Sons Company on their second bid of \$2,985,000, accepting the changes in design proposed by them. The contract for cruiser No. 6 (the 5,500-ton vessel) is given to the Union Iron Works, San Francisco, on their first bid of \$1,796,000, on the Department plans. Samuel L. Moore & Company receive the contract for the practice ship on their bid.

ENGINEERING IN THE FAR EAST.

OUR correspondent in Siam, who has been actively engaged in engineering work in that distant country, writes:

I am sorry to say that railroad affairs in Siam have not progressed since I last wrote to you. The Borapah Railroad Company was reorganized on a broader financial



TEN-WHEEL PASSENGER LOCOMOTIVE FOR THE CHESAPEAKE & OHIO RAILROAD.

BUILT BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

tender is carried on Boies steel-tired wheels 36 in. in diameter.

The total weight of the engine in running order is 132,700 lbs., of which 102,800 lbs. are carried on the drivers and 29,900 lbs. on the truck. The total weight of the tender in running order is 72,000 lbs., so that the total weight of engine and tender is a little over 102 tons.

It may be noted that the ten-wheel type is growing in favor for passenger engines designed for heavy work, and is now being introduced on a number of leading roads.

AERIAL NAVIGATION.

BY O. CHANUTE, C.E., OF CHICAGO.

(A lecture to the students of Sibley College, Cornell University; delivered May 2, 1890.)

UNTIL quite recent years, the possible solution of the last transportation problem remaining for man to evolve—that of sailing safely through the air—has been considered so nearly impracticable that the mere study of the subject was considered as an indication of lunacy.

And yet such measurable success has recently been achieved as to warrant good hopes for the future, and it is believed that speeds of 25 to 30 miles per hour, or enough to stem a wind less than a brisk gale, are even now in sight.

This is not unusual in the history of inventions. They are first proposed by the men of imagination, the poets and the dreamers, and next they are experimented upon by the more imaginative inventors, until at last some glimmer of success or some powerful incentive induces scientific men to investigate the principles, and ingenious inventors to endeavor to solve the problem.

Thus, if we are to believe ancient fable and history, desultory attempts to fly through the air followed close upon the invention of the land chariot and of the marine sail, but the mechanical difficulties in the way are so great that it is only since light primary motors have been evolved that any success at all has been achieved; and even now the students of the problem are divided into two camps or schools, each of which expects flight to be compassed by somewhat different apparatus. These are:

1. AERONAUTS, who believe that success is to come through some form of balloon, and that the apparatus must be lighter than the air which it displaces.

2. AVIATORS,* who point to the birds, believe that the apparatus must be heavier than the air, and hope for success by purely mechanical means.

Curiously enough, there seems to be very little concert of study between these two schools. Each believes the other so far wrong as to have no chance of ultimate success.

Their work will be described separately; and first that of the *Aeronauts*, in which it will be necessary to describe chiefly French achievements, that nation having taken the lead hitherto in studies aerial, probably in consequence of the invention of the balloon by Mongolfier in 1793.

AERONAUTS.

This great step (as it is believed to be) toward a possible solution of the problem at first excited the wildest hopes. Many believed the navigation of the air to be an accomplished fact. These hopes faded it was soon found that an ordinary spherical balloon was at the sport of the wind; and all sorts of impracticable devices were tried to control its motions, save till quite recent years (1852) that of furnishing it with a screw and an energetic motor.

While it is possible to impart low velocities, in calm air, to any kind of a balloon, yet the motive power which it could lift has been so small, and the consequent speed so inferior to that of ordinary winds, that until 1884 no balloon had ever come back to its starting-point.

We can perhaps best realize this deficiency of motive power by calculating approximately the speed which can be imparted to a spherical balloon by the motor it is capable of lifting; and instead of selecting one of those generally employed in ascensions, of 30 or 40 ft. diameter, we will take as an illustration the great captive balloon built

and operated by Giffard during the French Exposition of 1878, which was one of the largest and best ever built.

This was 118 ft. in diameter. Its volume was 882,925 cubic feet and its gross ascending power was 55,120 lbs. As the weight of the balloon proper, its car, appurtenances and fixtures was 30,536 lbs., there remained a net ascending power of 24,584 lbs., which might be utilized for a motor, its supplies, and a cargo.

Let us first calculate the resistance of the air to its motion.

Being a sphere 118 ft. in diameter, the area of its mid-section was 10,936 sq. ft. This would not, however, offer the same resistance as a flat surface, the experiments of Hutton and of Borda having shown that the resistance of a sphere is 41 per cent. of that of a flat surface of area equal to its mid-section.

But to this is to be added the surface of the car and rigging, as well as that of the motor, its framing and machinery conveying power to the propeller. This is generally found to be equal to about $\frac{1}{10}$ the area of the balloon, and as the surfaces are mostly flat, the resistance is usually estimated at 50 per cent. that of a flat plane. Reducing these two factors to their equivalent flat feet, we have:

$$\text{For the balloon: } \frac{10,936 \times 41}{100} = 4,484 \text{ sq. ft.}$$

$$\text{For the car etc: } \frac{10,936 \times 50}{10 \times 100} = 546 \text{ " "}$$

$$\text{Total equivalent flat surface } 5,030 \text{ sq. ft.}$$

We know by Smeaton's tables of air pressures that at a speed of 1 mile per hour the pressure upon a flat surface is 0.005 lb. per square foot, so that at this speed we may estimate the resistance of the balloon to be $5,030 \times 0.005 = 25.15$ lbs.—that is to say, that a force of but 25.15 lbs. continuously exerted would be sufficient to impart a speed of 1 mile per hour to this great mass in still air; and as this velocity is 88 ft. per minute, we have for the power required:

$$25.15 \times 88 = 2213.2 \text{ feet-lbs., or } 0.067 \text{ H. P.}$$

This seems small indeed, but as the power required increases as the cube of the speed, let us see how fast the balloon can be driven by any available motor.

The net ascending power is 24,584 lbs., but not more than half of this (as shown by the subsequent practice of Renard and Krebs) is available for the motor. The remainder is required for the framing, the propeller, the transmitting machinery, the stores of fuel or supplies and the aeronauts. We will assume therefore 12,584 lbs. for the weight of the motor proper, and that this weighs but 110 lbs. per H. P., as was the case with the steam-engine used by Giffard in his navigable balloon of 1852. The possible H. P. is therefore:

$$\frac{12,584}{110} = 114.4 \text{ H. P.}$$

If we suppose this to be exerted through an aerial screw, inasmuch as the best that has yet been publicly tried gives out but 70 per cent. of the power applied (the remainder being lost in slip), we shall have for the real available power $\frac{114.4 \times 70}{100} = 80$ H. P. But as the resistance in

still air requires an effective H. P. of 0.067 H. P. at 1 mile per hour, and the power required increases as the cube of the speed, we have

$$0.067 v^3 = 80; v = \sqrt[3]{\frac{80}{0.067}} = 10.6 \text{ miles per hour,}$$

as the utmost probable speed which could have been obtained with the most energetic motor which this great balloon could have taken up into the air.

How far this would fall short of stemming the prevailing winds will appear from the inspection of the following table, quoted by M. Gatendorf as the average velocities of wind observed during a period of ten years in Germany, there being during that time:

82	days of wind not exceeding	11.18 miles per hour
244½	" " " "	22.37 " " "
38	" " " "	42.50 " " "
½ day	" " " "	89.48 " " "

* From *avis*, a bird. This comparatively recent French term seems so appropriate as to warrant its adoption into English.

So that the occasions would indeed have been few upon which this air ship could have made any headway; yet had its possible speed been 25 miles per hour, it might have gone out about three-quarters of the days in the year; but in order to attain this speed it would have required a motor of nearly 1,500 H. P., which evidently it was quite impossible for it to lift.

Moreover, the recorded wind velocities are generally observed near the surface of the ground; but at comparatively moderate altitudes, say 1,000 to 1,500 ft. above the earth, they are much greater. Records kept at the top of the Eiffel Tower for 101 days (June to October, 1889) show an average velocity of 15.75 miles per hour, while a similar instrument 925 ft. lower down registered during the same time an average speed of but 4.90 miles per hour, or less than one-third of that at the top, 994 ft. in the air.

It is probably for lack of a realizing knowledge of this peculiarity that so many past experiments with navigable balloons have proved such disappointments. The aeronauts measured the speed of the wind at the surface, and only went up into the air to be swept away by a swifter current.

In view of the fact that wind velocities are much greater at sailing heights than at the surface of the ground, the opinion may be expressed that aerial navigation cannot be accounted even a partial success until a velocity of 30 miles per hour is obtained; but in order to remain well within the bounds of possibilities, the comparisons hereafter to be made will be based upon a speed of 25 miles per hour.

This brings us naturally to inquire as to what has thus far been done. It is clear that nothing was to be expected from any attempt to drive spherical balloons; that the resistance must be diminished in some way; and yet it took 79 years for aeronauts to realize the fact; for although General Meusnier had proposed them, and Robert Brothers had experimented with elongated balloons as early as 1784, it was not until 1852 that Henri Giffard, the future inventor of the injector, laid down the foundation for eventual success by ascending with a spindle-shaped air ship driven by a steam-engine.

GIFFARD'S BALLOON OF 1852.

On September 24, 1852, Giffard, then a young engineer 27 years of age, ascended from Paris in an elongated balloon filled with ordinary coal gas, driven by an aerial screw propeller actuated by a steam-engine of his own designing. He was at that time quite poor; but having been possessed since the age of 18 with the conviction that success was possible, he had communicated his enthusiasm to two of his college friends, who possessed limited means, and the three had contrived, amid many discouraging difficulties, to build and to equip this first navigable balloon.

It was in shape a symmetrical spindle, 144 ft. long and 39 ft. in diameter. The screw was three bladed and 11 ft. in diameter. The steam-engine was of 3 H. P., and weighed with the empty boiler 330 lbs., or 110 lbs. per H. P. In proportion to its power, this engine was much lighter than any previously built; but it was the utmost weight of motor which the balloon could lift, after making due allowance for the weight of the apparatus, its appurtenances, the aeronaut, the fuel, and the water. For the two latter 678 lbs. were allowed, of which 132 lbs. were in the boiler. Coke was employed as fuel, and the danger of setting on fire or exploding the gas escaping from the balloon was guarded against by surrounding the grate with a tight ash-pan, which again was surrounded with a vertical flue sheet. Thus no flame came into contact with the outer air, and the products of combustion, cooled in the return flue, were projected downward through an inverted smoke pipe, into which the steam from the cylinder was exhausted.

The cubic contents of the air ship were about 88,300 cub. ft., and being inflated with coal gas, its lifting power was 3,978 lbs. Had pure hydrogen been used instead, the lifting power would have been about 6,160 lbs., and a heavier motor could have been used; but this would have made little practical difference in the results as to speed. Fig. 1. is a side view of the entire apparatus. The surplus lifting power being only sufficient to carry up one man,

Giffard went up alone, at about 5.15 in the evening. The wind on the day previously selected for the ascension blew with considerable force, and Giffard knew from his calculated resistances that he could not hope to stem it; but having attained an altitude of about 5,000 ft., he set the engine in motion. With 110 revolutions of the screw per minute, he was enabled to get a proper speed of the apparatus, which he estimated at 4.27 to 6.70 miles per hour, so as to deflect and turn the balloon from the line of the wind; and thus, while satisfied that this first air ship was quite unable to cope with the wind that day or with those generally prevailing, he yet was enabled to announce his deliberate conclusion that ultimate success was certain with a larger balloon and a more energetic motor.

He further expressed his belief, as a result of this experiment, "that the danger resulting from the juxtaposition of fire and an inflammable gas might prove to be quite illusory;" but yet no other aeronaut since his time has dared to repeat the experiment.

He came down in safety just after dark, though not without some danger. It was clear that in order further to reduce the resistances a still more elongated balloon would be required, and he resumed his studies and designs for further experiments with unimpaired enthusiasm; but the means of himself and friends were so far exhausted that it was only in 1855 that he was enabled to make a second trial with what he considered an improved apparatus.

This new balloon was 230 ft. long and 33 ft. in diameter, being thus 7 to 1 instead of 3½ to 1, as in the former experi-

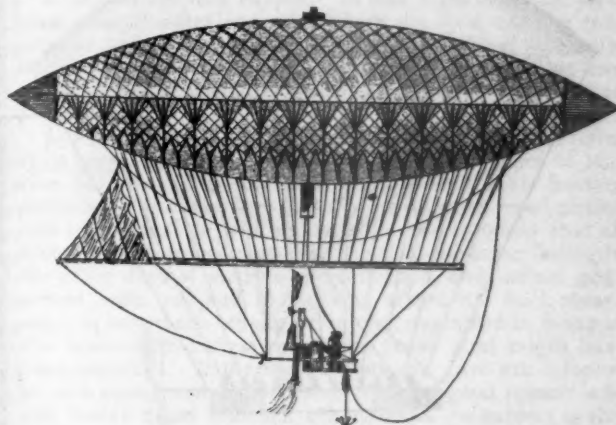


Fig. 1.

ment. This change, which was made to reduce the resistance, resulted in such longitudinal instability as nearly to cost Giffard his life. He was on this occasion enabled to take up a companion (M. Gabriel Yon) to assist in the manoeuvres, but notwithstanding this, the balloon would not keep a level keel. The wind blew, and although he attained greater speed than on the former occasion, he was unable to stem the current for more than a few minutes at a time, with all the power of his engine. One end of the balloon tipped up, and the flow of the gas toward that end aggravated the evil. The valve was at once opened, and the aeronauts came down as rapidly as they could; but just as the ground was struck with considerable violence, the gas bag, tipping up more and more, slipped out of the netting and went to pieces.

This accident did not alter Giffard's conviction of ultimate success, but he determined first to make a fortune. He shortly thereafter invented the injector and eventually became a millionaire, while at no time did he abandon his aeronautical studies.

In order to work out practically all the details as to gas-tight envelopes, stability, appliances, manufacture of hydrogen, etc., he built in 1867 the great captive balloon for the Paris Exposition of that year. In 1868 he built one in London, and again in 1878 he carried out further improvements in a new captive balloon at the Paris Exposition, this being the one which has already been alluded to.

At length, in 1881, he determined upon the construction of a gigantic air ship, to contain 1,766,000 cub. ft. of hydrogen and to cost \$200,000, out of which he expected a

speed of nearly 45 miles per hour; but he was near the end of his career. First his health failed, and then his eyesight; he became a recluse; and finally, discouraged and maddened by physical pain, he died by inhaling chloroform in April, 1882.

Giffard was thus the first to drive a balloon with a motor, and this he did with a steam-engine. It is probable that men before now have gone into a powder magazine with a lighted torch and have come out in safety; still the practice is not to be commended. So Giffard went up with a lighted steam furnace under a gas bag open to the air through its lower valve and he came down safely not once only, but twice; and yet other aeronauts believe the practice so dangerous that not one thus far has repeated the experiment.

THE DUPUY DE LÔME BALLOON, 1872.

During the siege of Paris, in 1870, some 65 ordinary balloons left the beleaguered city, but notwithstanding many efforts, not one of them succeeded in getting back. The Government decided in October upon building a navigable balloon, to restore communications, and entrusted its construction to M. Dupuy de Lôme, Chief Naval Constructor, to whose skill was largely due the success of the earlier armored ships of France. He went most carefully into the questions of balloon resistances, stability and working details, and pushed the construction as fast as the disorgan-

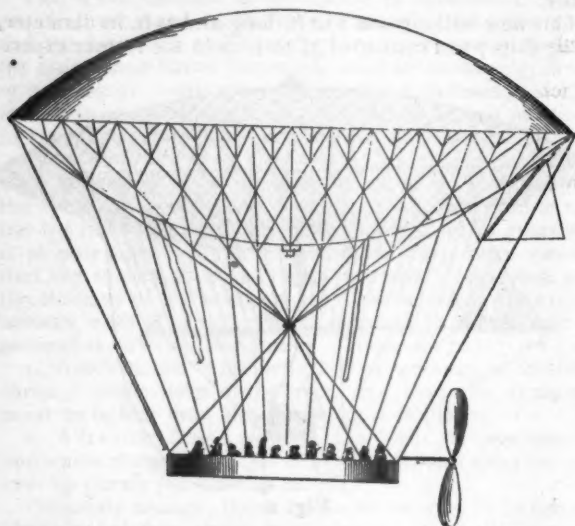


Fig. 2.

ized industry of the city would permit; but nevertheless the apparatus was completed only a few days before the capitulation.

Then came the insurrection of the "Commune," so that it was only on February 2, 1872, that the merits of the air ship could be tested.

The balloon was also a symmetrical spindle, 118½ ft. long and 48½ ft. in diameter (2.43 to 1). It contained 120,088 cub. ft. of pure hydrogen, and its lifting power was 8,358 lbs. Its principal features of novelty were a system of triangular suspension, by which all weights were concentrated at a single point a short distance above the car, and the introduction inside of the gas bag of an air pocket or bag, say one-tenth in cubic displacement of that of the balloon, so as to keep it distended and rigid at all times, by blowing in or letting out air. This valuable device was found to remove, for low velocities at least, the danger of deformation from end thrusts or resistance of the air. We shall find it used again in the Renard and Krebs experiments of 1884-85. Fig. 2 is a side view of this air ship.

Dupuy de Lôme's ultimate purpose was that his balloon should be driven with an engine of some sort; but from a wholesome dread of fire, he tried his experiment with hand power. The total crew consisted of 14 men, of whom 8 laborers turned a winch, imparting 27½ revolutions per minute to a two-armed aerial screw 29½ ft. in diameter. This drove the apparatus at a speed estimated at 6.26 miles per hour, with an expenditure of say 0.8 H. P. It is be-

lieved that the speed was overestimated, but in any event it proved insufficient to stem the wind on the day of the trial. Dupuy de Lôme estimated that by substituting a steam-engine of 8 H. P., representing the weight of 7 men, or say 1,200 lbs., he could obtain a speed of 13½ miles per hour; but the experiment was not made, and the next in date was

THE TISSANDIER ELECTRICAL BALLOON, 1883.

Impressed with the belief that recent improvements in electrical engines afforded a safe and convenient motor for balloons, M. Gaston Tissandier, the distinguished author and aeronaut, constructed in 1883, with the co-operation of his brother, a navigable balloon 92 ft. long and 30 ft.

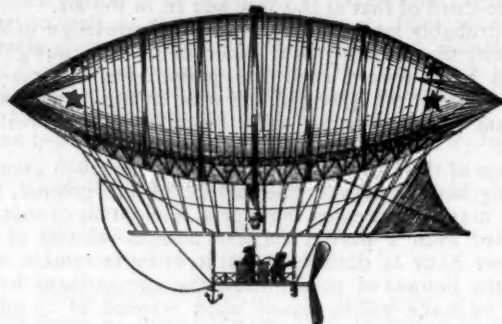


Fig. 3.

in diameter (3.04 to 1), inflated with 37,439 cub. ft. of hydrogen, and with a lifting power of 2,728 lbs.

The netting in this case was formed of flat ribbons sewed to longitudinal gores, which arrangement was found materially to diminish the air resistance due to the ordinary twine netting. The apparatus was driven by a Siemens dynamo weighing 99 lbs., actuated by a primary battery (bichromate of potash) weighing 517 lbs. more and capable of developing 1½ H. P. for 2½ hours. The screw was 9.18 ft. in diameter, with two arms, and was rotated at 180 revolutions per minute. Fig. 3 shows this apparatus.

Two ascensions were made. The first was on October 8, 1883. On this occasion there was almost no wind at the surface, but at a height of 1,600 ft. it was blowing at the rate of about 6.7 miles per hour. It was found that the apparatus was just able to stem it, exerting the full power of the motor. After performing various evolutions the aeronauts came down, intending to go up again the next day; but the weather being cool, the bichromate solution froze during the night, and although the balloon had apparently lost no gas, it was decided to empty it and to try it again after making some modifications in the rudder, which had not been found to work well.

The second ascension took place September 26, 1884, and on this occasion the balloon was found to obey its helm perfectly, to perform various evolutions and to attain a speed which, although inferior to that of the wind that day, was estimated by M. Tissandier at 9 miles per hour. This probably was also an overestimate. The longitudinal stability was satisfactory, and the necessary endwise rigidity was secured by maintaining an internal compression in the gas bag by means of a safety valve.

In neither trial could the air ship return to its starting-point because of the wind, and the results were so far inferior to those obtained at about the same time by the French War Department, that these costly experiments, which had been carried out at private expense, chiefly in the interest of science, by two gentlemen of limited means, were not prosecuted further. They had pointed out the way, and established that by the substitution for steam of electric power, the following advantages were gained:

1. All danger from firing the gas was avoided.
2. The apparatus did not vary in weight.
3. The motor was more easily managed.

Others stepped in with abundant backing to carry on the evolution of the problem.

(TO BE CONTINUED.)

TUBULOUS BOILERS.

(Paper read by Assistant Engineer S. H. Leonard, U. S. N., before the American Society of Naval Engineers, and published in the *Journal of the Society*.)

ONE of the most important questions arising in connection with marine machinery at the present time is that concerning the improvement of the steam generator. The Scotch boiler, now in universal use, leaves much to be desired even at present pressures, and if quadruple-expansion engines are soon to supersede the triple type, as now seems highly probable, steam of 225 to 250 lbs. pressure per square inch must be supplied, necessitating a radical change in the general type of boiler from that now in use.

At the present time, with but few exceptions, quadruple-expansion engines are working at a pressure of 180 lbs. only. This is accounted for by the fact that hitherto it has been found impossible to construct a marine boiler capable of withstanding pressures much exceeding 160 lbs. without considerably reducing the diameter or increasing the thickness of the shell plates. A reduction of diameter is obviously a backward step, while steel plates $1\frac{1}{2}$ to $1\frac{3}{4}$ in. thick are about the maximum capable of being worked with satisfaction on the one hand, or of being used for the transmission of heat on the other.

In connection with the reduction of diameters, boilers of the locomotive type have frequently been tried, and some engineers are looking to this class of boiler as offering some advantage in regard to reduced weight, as well as in their adaptability to increased pressures. Their performances, however, up to the present time have been far from satisfactory; many accidents have occurred on board the torpedo-boats fitted with them, several of which were fatal; and serious leaks about tubes and seams develop after a short period of rapid steaming under forced draft. In several cases where they have been fitted in battery, they proved costly failures, the cases of the English torpedo ram *Polyphemus* and the *Flavia Gioga* of the Italian Navy being notable. Although the *Lepanto*, of the Italian Navy, has recently been fitted with 16 boilers of the locomotive type, in battery, and a favorable report made on their trial, little seems to have been proved thereby, as the conditions were far from severe. As the *Lepanto* is a ship of over 15,000 tons displacement, and the trials took place in smooth water, the boilers were perfectly steady, and consequently there was no uncovering of heating surfaces with the attending evils, so great in this type of boiler. The safety valves were loaded to the very moderate pressure of 60 lbs. per square inch. The speed trials seem to have been of rather short duration, and yet after each forced draft trial the boilers had tubes leaking.

Many are looking to the type known as the water-tube or tubulous boiler for the solution of this question of higher pressures. This certainly has many advantages claiming attention, which may be itemized as follows:

Higher pressures.—One of the most important features of this type of boiler is its capability of working at any pressure which can be utilized by the steam engine, and at the same time the danger from explosion is greatly reduced.

Weight.—As the parts of the boiler are small, the scantlings may be light and the requisite factor of safety retained, while at the same time a more free transmission of heat from the fuel to the water is secured. The water in the tubulous boiler averages from 5 per cent. to 15 per cent. of the weight of the empty boiler, while in the Scotch type the average is from 60 to 65 per cent.

Rapidity of generating steam.—The large and effective heating surface, together with the small bulk of water, which has a rapid circulation, enables this type of boiler to generate steam very rapidly without injury thereto, which is always a great advantage, and especially so in naval vessels.

Facility in making repairs.—The parts, being small and comparatively light, can readily be carried in duplicate and fitted, when necessary, with little expenditure of time or skill.

The Thornycroft boiler, it is stated, has attained, with natural draft, an efficiency of 87 per cent. of the theoretical

evaporation, which is believed to be the highest result on record.

The principal requisites of a tubulous boiler are:

1. **A free and natural circulation.** The serious lack of this property in the earlier water-tube boilers built from 1870 to 1875, and fitted in the *Montana*, *Propontis*, *Birkenhead*, *Meredith*, *Marc Antony* and other ships, was the primary cause of their disastrous failures. Circulation, in order to be natural, should be a systematic motion of the water from the upper to the lower part of the generator, and thence again to the surface, the steam when formed having a free and direct flow to the steam chamber or drum, and there being an equally free and direct flow for the water displacing it. In the later successful water-tube boilers every means is taken to facilitate this cycle of operations. Downcast pipes are provided to effectually prevent any confusion or want of order in the general circulation, and as the flow in these pipes is always to be in one direction, downward, they should be so placed as to be free from any causes, however slight, tending to produce an opposite flow. In the older forms of boiler the circulation depended upon slight variations of density of the water in its different parts, and although its motion might be energetic during rapid ebullition, it was without system or order; each drop of water was struggling to get somewhere or anywhere, and continually in conflict with its neighbor. This is practically the circulation going on in the ordinary Scotch boiler, and is very different from the systematic rotation taking place in a well-designed tubulous boiler.

2. **A positive feed supply.** In this class of boiler, with such a small water capacity, where the feed must be continuous and yet variable in amount, some kind of automatic device becomes necessary to assist those in charge, and this is especially a matter of concern when they are worked in battery.

3. **Pure water.** The necessity for pure water is certainly as great as, if not greater than with other types of marine boilers. It is said that the tubes and other heating surfaces of the tubulous boiler are subject to rapid pitting and corrosion. It will probably be remembered that all forms of marine boilers were subject to the same failing in the early days of surface condensation, and indeed until means were adopted to check or arrest it. Such means seem to have been wholly or in part neglected in many of the water-tube boilers, with the result that might have been expected. If the same means and care are adopted in each case, there would seem to be no good reason why one boiler more than the other should be subject to this action.

4. **Care.** The life of a tubulous boiler will certainly be short without intelligent and systematic care. If builders would bear this fact in mind and use their ingenuity in making all parts of their inventions more easily accessible for frequent cleaning as well as for occasional repairs, much would be accomplished toward prolonging the life of the boiler.

Because the tubulous boiler is composed of many elements, any one of which can be easily repaired or replaced, is no excuse for trying to prolong its allotted existence, which would simply result in continual annoyance and anxiety from frequent break-downs. As a consequence, it would seem useless to carry any greater relative proportion of duplicate parts for this type of boiler than for any other.

The accompanying table—No. I—gives the results of a number of tests of tubulous and other boilers, for comparison.

This table has been prepared from data of evaporation tests made at different times by boards of United States naval engineers. The locomotive boiler test is an exception, however, it having been made in England on the boilers fitted in the Italian torpedo-boats *Tripoli* and *Folgore*. Although these tests were not strictly comparable, on account of the great disparity in sizes of boilers, ratios of heating to grate surface, and variety of working, they can be taken to fairly represent the comparison intended by the writer: the relative weight and space occupied by the three types of boiler—tubulous, locomotive and Scotch.

In the case of the large Ward boiler, the grate area and

TUBULOUS BOILERS.—TABLE I.

TYPE.	DIMENSIONS.	Grate Area.	Heating Surface.	Ratio.	COMB'N	EVAPORATION FROM AND AT 212° F.				Per cent. Moisture.	WEIGHTS.					Air Pressure, Ins. of Water.	Steam Pressure, Lbs.	Coal.
						Per Sq. Ft. Grate.	Per Lb. Coal.	Per Lb. Comb'le.	Per Sq. Ft. H. Surface.		Per Cu. Ft. Space.	Empty Lbs.	Steaming Level.	Per I. H. P.	Per Sq. Ft. H. Surface.				Per Lb. Water Evaporated.
Belleville.	Length, 8'-6" Width, 7-0 Height, 11-0 Space, 654.5 cu. ft.	34.17	804	1 to 23.5	12.8	9.6	10.42	5.2	6.4	6.31	40,670	42,770	204	53.2	10.1	Nat'l.	111	Bit.
Herreshoff.	Length, 4'-9" Width, 3-8 Height, 4-0 Space, 69.6 cu. ft.	9	205.3	1 to 22	9.3	7.6	10.23	3.1	9.1	3.5	2,915	3,030	96	14.8	4.8	Jet.	120	Anth.
					25.8	7.14	8.68	8	23.8	....			36	1.8		Jet.	195	do.
Towne.	Length, 2'-6" Width, 2-6 Height, 3-3 Space, 20.3 cu. ft.	4.25	75	1 to 17.6	4.3	10.46	13.4	2.7	10 *	....	1,380	1,640	172	21.8	8.1	Nat'l.	148	Anth.
					24.5	5.6	6.77	8.2	30.4				56	2.6	1.14		152	do.
Ward.	Diameter, 3'-2" Do., Drum, 1-7 Height, 7-2 Space, 42.7 cu. ft.	3.68	145.8	1 to 39.5	7.9	8.59	10.77	1.7	5.8	....	1,682	1,930	82	13.2	4.07	Nat'l.	0	Anth.
					15.5	8.28	10.01	3.2	11				26	1.3		Jet.	17	do.
					62.5	6.34	7.01	10	34.2							Jet.	161	Bit.
Scotch.	Diameter, 9'-0" Length, 9-0 Space, 572.5 cu. ft.	31.16	727.2	1 to 23.3	24.8	8.13	9.93	8.6	11	3.44	18,900	30,000	120	41.2	4.7	2.08	77	Anth.
					38	7.87	9.06	12.8	16.3	4.29			80	3.1	4.01		78	do.
Locomotive torpedo.	Length, 16'-8" Width, 6'-4" Height, 7'-6" Space, 630.3 cu. ft.	28	1,116	1 to 39.8	98.3	6.97	....	17.1	30.5	....	....	34,990	47.7	31.3	1.8	3.13	125	Bit.
					120.8	6.62	....	20.05	36.2				33.3	1.2	4.95		123	do.
Ward.	Diameter, 10'-3" Do., Drum, 4-6 Height, 11-8 Space, 720.3 cu. ft.	53	2,473.5	1 to 46.6	55.04	8.03	8.44	9.47	32.1	11.6	26,533	30,474	26	12.3	1.3	2	160	Bit.
		66.5	2,490	1 to 37.4														
Thorncroft. (U. S. S. Cush- ing.)	Length, *10'-0" Width, *7'-0" Height, *8'-0" Space, *560 cu. ft.	38.3	2,375	1 to 62	45	....	....	....	....	....	20,160	24,640	*31	10.3	....	3	245	Bit.

* Approximate.

TABLE NO. II.

TYPE OF BOILER.	1.	2.	3.	4.	5.
	Combustion.	Evaporation per Cu. Ft. of Space.	Weight per I. H. P.	Weight per Sq. Ft. Heating Surface.	Weight per Lb. Water Evaporated.
Belleville	0.50	0.50	2.02	2.10	2.50
Herreshoff.....	1.00	0.95	0.72	0.60	0.90
Towne	1.00	1.20	1.12	0.87	1.30
Scotch.....	1.00	0.44	2.40	1.64	2.30
Locomotive.....	3.90	0.31	3.70	1.25	3.50
Ward	2.20	0.58	1.27	0.50	1.53

heating surface used are given; the actual areas are added below. The evaporation, apparent in each case, is from and at 212. Where calorimetric tests were made the percentage of moisture is given.

The weight per I. H. P. is estimated on a basis of 20 lbs. of water per hour for all cases excepting the Scotch boiler,

where 25 lbs. have been used, as this boiler was limited to 80 lbs. pressure of steam.

The accompanying approximation, Table II., is made from the large table, on the assumption that the evaporation varies directly as the combustion, and 25 lbs. of coal per square foot of grate per hour used as the unit.

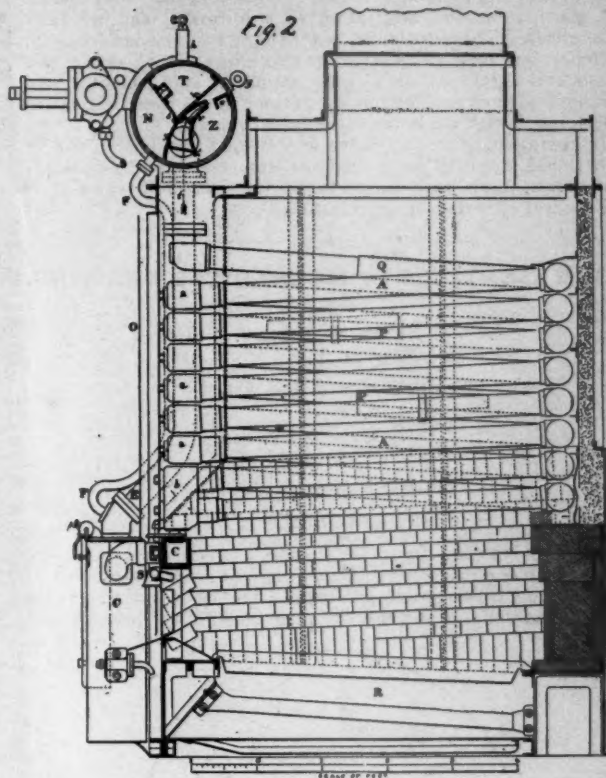
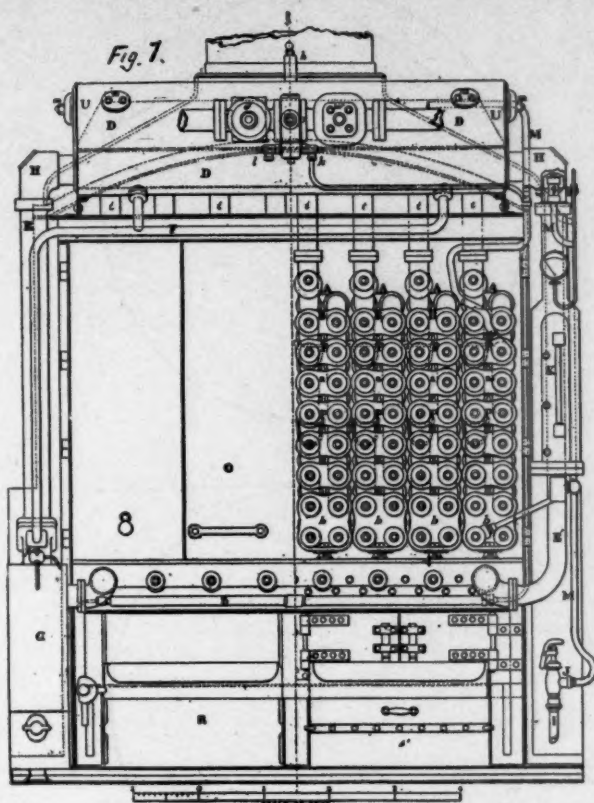
The assumption noted above is manifestly unfair to those boilers using a high rate of combustion; however, leaving the small Ward boiler out of the comparison, it will be seen that the locomotive boiler is the only one to suffer. The large Ward boiler, although burning 55 lbs. of coal per square foot of grate, has approximately the same evaporation per pound of coal as the others at 25 lbs. These figures, speaking for themselves, need but little comment. The locomotive boiler should receive a favorable correction of about 20 per cent. in columns 2, 3 and 5, on account of the high rate of combustion. On the other hand, the Belleville boiler should receive an adverse correction of about 10 per cent., on account of low combustion; but even without this correction, it is seen that this boiler has no practical advantage over the Scotch either in space occupied or weight. All the other tubulous boilers given greatly exceed the Scotch in these advantages of weight and space.

THE BELLEVILLE BOILER.

This boiler, as shown in figs. 1 and 2, consists of a system of tubes of equal length joined together by junction boxes of malleable steel, so as to form a series of flat coils, each of which is connected to the feed-water box *C* at the

eration and a great convenience in case of repairs. The feed-water box is of iron, forged in rectangular section.

The interior of the drum is divided into three nearly equal compartments, *Z*, *T* and *N*, by diaphragm plates *x*, *y* and *s*, extending its whole length, bent and riveted together along a line near the axis.



THE BELLEVILLE BOILER.

lower end of the coil, and to the steam-drum *D*, at its upper end. The steam drum, into which the feed water is delivered, is connected with the feed-water box and a vertical cylindrical vessel, called a sediment collector, by two outside pipes *E* and *E'*, the one on the starboard end leading direct to the feed-water box. This arrangement permits of a continuous circulation of water and steam through the tubes to the drum, and of the water from the drum to the feed-water box.

The tubes are of lap-welded wrought-iron, 3.9 in. outside diameter. The back junction-boxes are simple U-connections, the lowest of these boxes, *b b*, resting directly on the feed-water box, having each four openings for the reception of tubes, one opening in the lower row being blanked off; the other front junction-boxes, *a a*, form simple horizontal U-connections like those at the back. The lower front junction-boxes have two chambers, the upper one forming a U-connection, and the lower one, which receives the lower end of the last tube, connecting with the water-box. On the front of each front junction-box there are sight holes, closed by wrought-iron plugs, each held in place by a single T-head bolt and nut, the joint being made with linen asbestos cardboard.

Each tubular element, *A A*, is complete in itself and independent. In case of any accident to a tube or tubes of an element, the latter can be readily and quickly disconnected, the connection holes blanked, and the rest of the boiler used without inconvenience. The tubes are screwed into the back junction-boxes with ordinary pipe threads, and further secured by jam-nuts; at the front ends they butt against nipples, threaded similarly to the tubes, and are held in place by screw-couplings, shouldered against the faces of the boxes and secured by jam-nuts on their backs. By this arrangement any two tubes, connecting in the same back junction-box, may be removed and replaced without disturbing any of the others, a valuable consid-

The circulation in this boiler is as follows: Water passes by a pipe *I*, through a graduated check valve *J*, to the feed pipe *M*, thence to an automatic feed regulator *g*, secured to the stand-pipe *K*, and to which is attached the water-gauge glass. From the regulator the water passes, by means of pipe *M* (*g* in side view), to the longitudinal center of the steam-drum *D*, delivering just above the shelf *e*, where it meets the steam delivered into *Z* through *t t*; here it thoroughly mixes with the steam, which is supposed to heat it sufficiently to precipitate the lime salts, which, falling to the bottom of *Z*, are carried along with the water through the pipe *E* to the sediment chamber, and by pipe *E'* to the feed-water box direct.

The water flows from the sediment collector to the feed-water box, which supplies the several series of tubes, the water and steam passing by pipes *t t t* to the chamber *Z* in the drum. The steam escapes through the triangular openings *U* and *U'* into *T*, and thence through the dry-pipe *r* into *N*, from which it passes to the stop valve *w*, or safety valve *d*.

(TO BE CONTINUED.)

Violence and Strikes.

A CONFERENCE was recently held in Belgium of delegates who represented 265,000 unionist miners. It was presided over by Mr. Thomas Burt, M.P. In his speech he said:

"British unionists were strongly opposed to violence and illegality. Let them regard as their greatest enemies, in whatever guise of friendship they came, those who counselled intimidation, violence and outrage. Such advice was not only imprudent and suicidal, but in a free country it was wicked and criminal in the extreme. Let them trust to the reasonableness of their cause."

With regard to strikes, Mr. Burt said: "He was not prepared to condemn them without qualification. In the last re-

sort a strike was the only weapon available to the workmen; but it was a two-edged weapon, that required to be used with skill and discrimination, or it recoiled on the heads of those who used it. Young societies rushed into strikes without thought; they were often defeated, disheartened, disorganized, and placed in a worse position than they were before." Referring to peaceful methods, he said: "In every case they should try conciliation and arbitration as a means of settling their differences. These were the lessons they had learned from experience, and their gains were the result of patient, steady, and persistent agitation, by legal, rational, and constitutional means." He counselled united action, rather than legislative interference with the hours of full-grown men.

In commenting upon this subject the editor of *Engineering* says: "If English labor disputes are severe and prolonged sometimes, they have ceased to be riotous. Self-restraint is the natural offspring of organization."

THE ESSENTIALS OF MECHANICAL DRAWING.

BY M. N. FORNEY.

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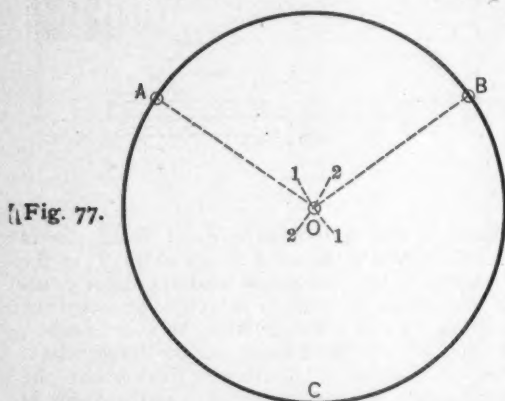
(Continued from page 279.)

CHAPTER III.—(Continued.)

CIRCLES.*

PROBLEM 32 (fig. 77). To describe a circle or arc of a circle passing through two given points and with a given radius.

Let A and B be the two points, and the radius = r . From A and B as centers and this distance as a radius describe arcs



1 and 2 intersecting each other in O . Then O will be the center of the proposed circle from which it can be drawn, and will pass through the points A and B .

PROBLEM 33 (fig. 78). To describe a circle whose circumference shall pass through three given points which are not in a straight line.

Let A , B and C be the three points. Join them by the chords AB and BC . Bisect the chords by perpendiculars DO and EO . Their point of intersection, O , will be the center of the proposed circle, which may be drawn from this center with a radius OA , so as to pass through the three given points.

PROBLEM 34 (fig. 79). To find the center and radius of a given circle.

Let ABC be the given circle. Between any three points, A , B and C , draw chords AB and BC . Bisect these chords by perpendiculars FO and GO . Their point of intersection, O , will be the center of the circle, and its radius will be OH or OJ .

PROBLEM 35 (fig. 79). To draw a tangent to a circle at a given point in its circumference.

* A circle is defined as "a plane figure bounded by a curved line, every point of which is equally distant from a point within called the center." The outside or bounding line is called the circumference.

† A chord is a straight line joining the extremities of an arc. Thus the straight line AD , fig. 78, is the chord of the arc AHB .

‡ A line is said to be tangent to a circle when it touches the circle at one point, but does not intersect or cut off any portion of the circumference. A tangent to a circle is always perpendicular or at right angles to the radius drawn from the point at which it touches to the center of the circle. It

Let A be the given point in the circumference of the circle. From A to the center of the circle draw the radius AO .

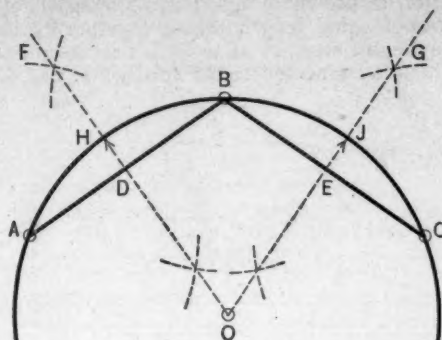


Fig. 78.

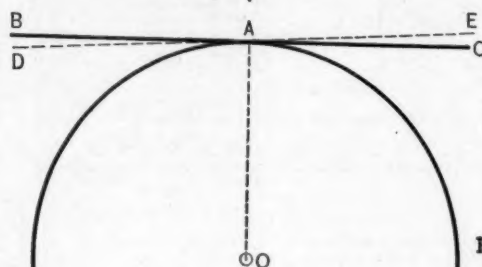


Fig. 79.

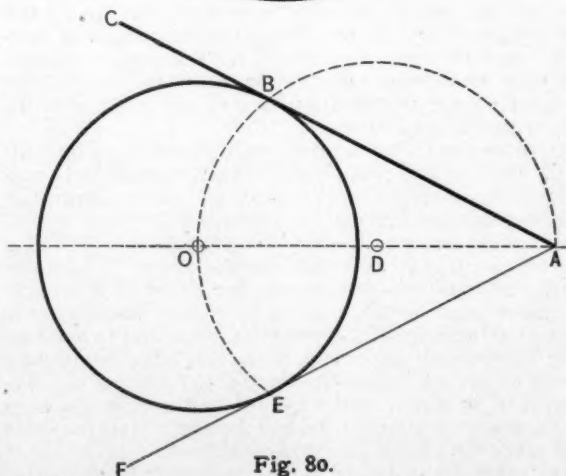


Fig. 80.

Through A draw BC perpendicular to AO . BC will then be tangent to the circle at A .

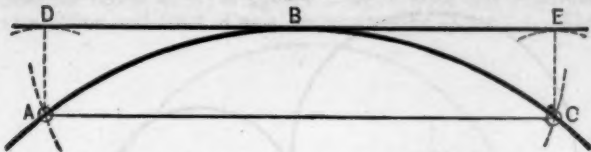
PROBLEM 36 (fig. 80). To draw a tangent to a circle from a given point without the circumference.

Let A be the given point. Join A and the center O of the circle by the line AO . Bisect AO at D , and from D as a center and a radius DA or DO draw the semicircle OBA , cutting the circle in B . Through the points A and B draw

apparently would be very easy to draw a straight line, DE , fig. 79, with a ruler which would touch the circle at the point A , but if the line was not perpendicular to a radius drawn through A , it would in reality not be tangent to the circle at that point, but to some point on one side of A . In drawing it is often important that the position of a tangent should be correct, and therefore it should be drawn perpendicular to the radius at the tangent point.

the line $A B C$, and it will be tangent to the circle at B . If the semicircle $A B O$ is extended so as to intersect the circle at

Fig. 81.



E , and the line $A E F$ is drawn, it will also be tangent to the circle at the point E .

PROBLEM 37 (fig. 81). To draw a tangent to an arc of a circle, passing through a given point in the arc, when the center is not accessible.

Let $A B C$ be the arc and B the point upon the arc at which the tangent is to be drawn. Lay off equal distances $B A$ and

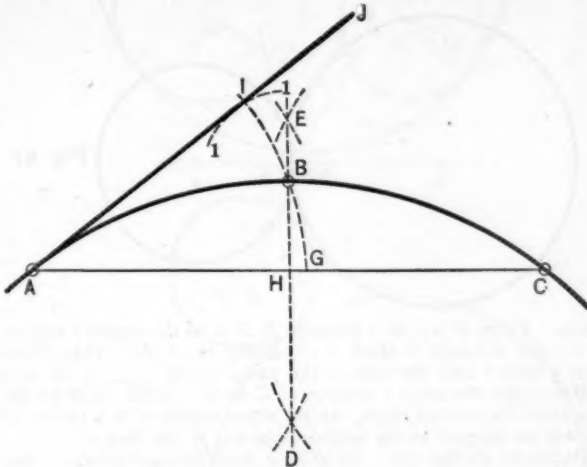


Fig. 82.

$B C$ upon the arc from B to A and C . Join A and C by the line $A C$. Then through B draw a line $D B E$ parallel to $A C$, and it will be tangent to the arc at B .

PROBLEM 38 (fig. 82). To draw a tangent to an arc passing through a given point in the arc when the preceding method is not applicable.

Let $A B C$, fig. 82, be the arc and A the tangent point. From A draw any chord $A C$. Bisect it by the line $D E$ by Problem 5.

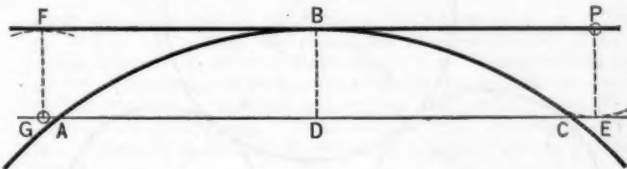


Fig. 83.

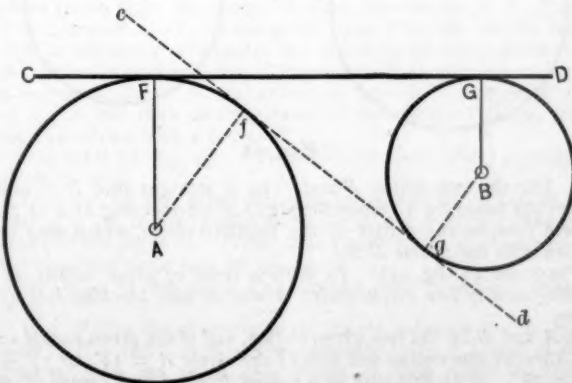


Fig. 84.

From A as a center and $A B$ as a radius draw the arc $I G$. From B as a center and with $B G$ as a radius draw an arc $I H$, cutting $I G$ at I . Through A and I draw the line $A I J$, and it will be the required tangent.

PROBLEM 39 (fig. 83). To draw a tangent to an arc of a circle from a given point without the arc, the center not being accessible.

Let $A B C$ be the arc and P the given point. From P draw the line $P B F$ touching the arc. To ascertain the true tangent point at any convenient distance from $P B$, as $P E$, draw $E D G$ parallel to $P B F$, and cutting the arc at C and A . Bisect the chord $A D C$ at D , and from D erect a perpendicular $D B$, cutting the arc at B ; then will B be the true tangent point of $F B P$ to the arc.

PROBLEM 40 (fig. 84). To draw a tangent to two given circles.

Let A and B be the two circles. Draw the line $C D$ so as to touch both of them. To ascertain the true tangent points,

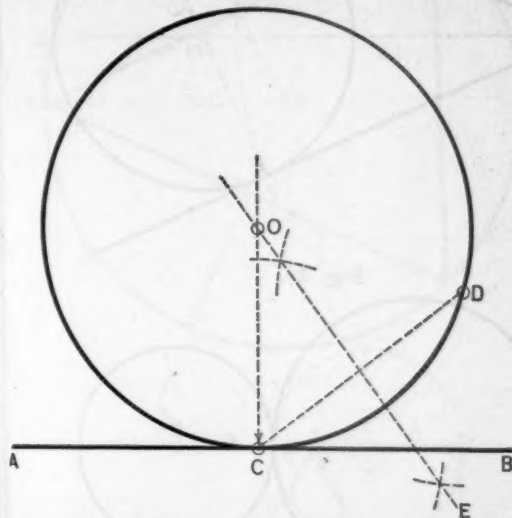


Fig. 85.

from the centers A and B of the two circles draw $A F$ and $B G$ perpendicular to $C D$. F and G will then be the points required.

The same method may be adopted if the tangent should be required to pass between the two circles, as represented by the dotted line $c d$. Lines $A f$ and $B g$ drawn perpendicular to $c d$ and through A and B will give the true tangent points, f and g .

PROBLEM 41 (fig. 85). To draw a circle tangent to a given line $A B$ at a given point C in it, and which shall also pass through a fixed point D without the line.

If C be the point in the line $A C B$ and D the point without the line, from C draw $C O$ perpendicular to $A C B$. Join C and

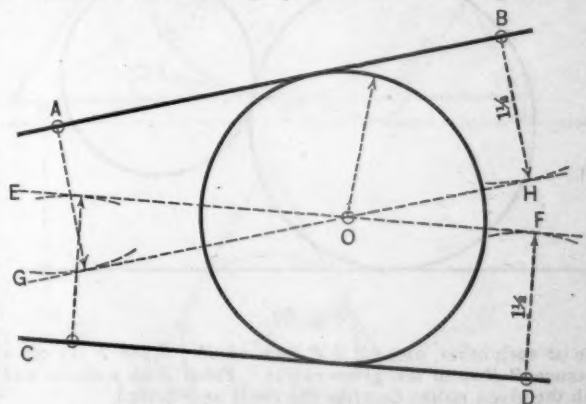


Fig. 86.

D by a line $C D$, and draw a perpendicular $O E$ bisecting $C D$ and intersecting $C O$ in O . O will then be the center of the required circle, which may be drawn from it with a radius $O C$ so as to be tangent to $A C B$ at C and also pass through D .

PROBLEM 42 (fig. 86). To draw a circle of a given radius tangent to two given inclined lines, $A B$ and $C D$.

If $A B$ and $C D$ be the two inclined lines, and the radius of the circle $= 1\frac{1}{2}$, then by Problem 3 draw lines $E F$ and $G H$ parallel to $A B$ and $C D$, and at a distance, $B H$ and $F D$, from them $=$ the radius of the circle. The point of intersection, O , of these lines will be the center of the circle from which it may be drawn with the given radius.

PROBLEM 43 (fig. 87). To draw a circle that shall touch two straight lines, $A B$ and $A C$, which are inclined to each other, the circle to be tangent to one of the lines in a given point.

If $A B$ and $A C$ be two inclined lines, which meet in the vertex A , and P be the given point, bisect the angle $B A C$

by a line AD . From P draw a line PO perpendicular to AC . Then the intersection O of AD and PO will be the center of the circle, which may be drawn with the radius OP .

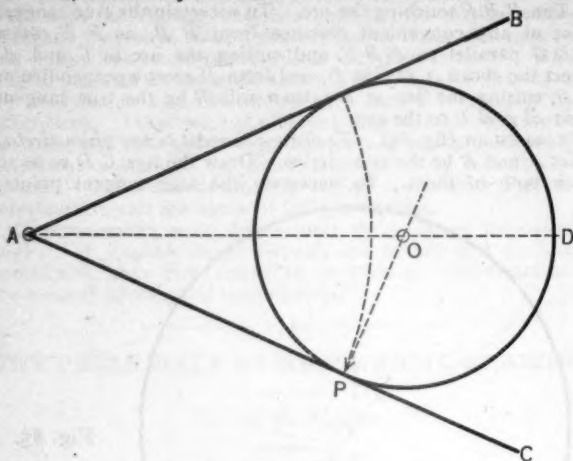


Fig. 87.

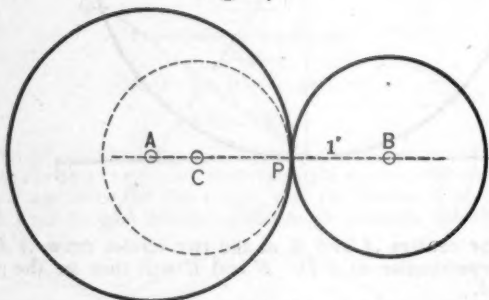


Fig. 88.

PROBLEM 44 (fig. 88). To describe a circle B of a given radius, touching another given circle A at a given point P .

If A be the given circle, P the given point, and the given radius $= r'$, from A , the center of the given circle, draw a straight line $A'P$ through P . If the two circles are to be out-

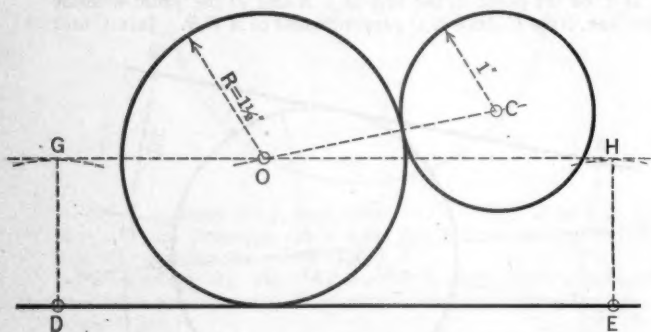


Fig. 89.

side of each other, extend AP beyond P . From P lay off a distance $PB =$ to the given radius. From B as a center and with the given radius describe the circle as required.

If the circle required must be inside of the given circle, then from P lay off a distance PC toward the center $A =$ to the given radius. C will then be the center of the required circle, which may be drawn from it with the given radius.

PROBLEM 45 (fig. 89). To draw a circle O of a given radius, which shall be tangent to a given circle C , and also tangent to a straight line DE .

If the radius R of the circle is $1\frac{1}{2}$ in., draw GH parallel to DE at a distance $DG = R = 1\frac{1}{2}$. If the radius of $C = r'$, then with C as a center and the sum of the two radii—that is, $1\frac{1}{2} + r' = 2\frac{1}{2}$ —draw an arc intersecting GH in O . Then O will be the center from which the circle may be drawn with a radius $= 1\frac{1}{2}$, which will be tangent to C and to DE .*

PROBLEM 46 (fig. 90). To describe with given radii two circles, O and C , touching each other, and also a given line AB .

* If two circles are tangent to each other, a straight line connecting the centers of the circles passes through their tangent point. It is often important to locate this point precisely.

Let AB be the given line, and the radii of the circles $= 1\frac{1}{2}$ and r' . From any point E on AB draw EO perpendicular to AB , and from E lay off a distance EO equal to $1\frac{1}{2}$ the greater radius. From O as a center and $1\frac{1}{2}$ as a radius draw the larger

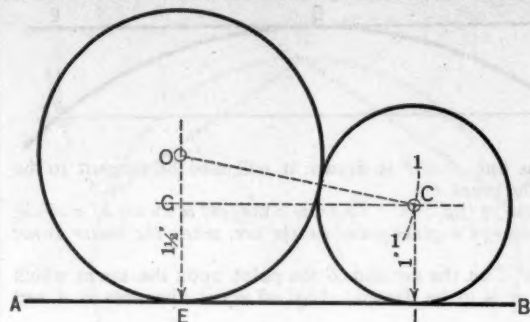


Fig. 90.

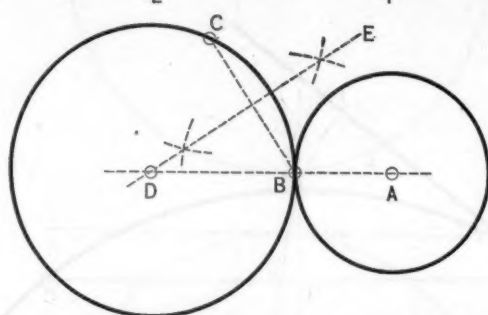


Fig. 91.

circle. From E lay off a distance $EG =$ to the smaller radius, or r' , and through G draw GC parallel to AB . Then from O as a center and the sum of the radii, or $1\frac{1}{2} + r' = 2\frac{1}{2}$ as a radius, draw the arc 11 cutting GC in C . C will then be the center of the second circle, which, when drawn with a radius of r' , will be tangent to the larger circle and to the line AB .

PROBLEM 47 (fig. 91). To draw a circle through a point C and tangent to a given circle A at a given point B in its circumference.

If A be the given circle, B the tangent point, and C the given point without the circle A , through the center A and the tangent point B draw a straight line AB and extend it toward

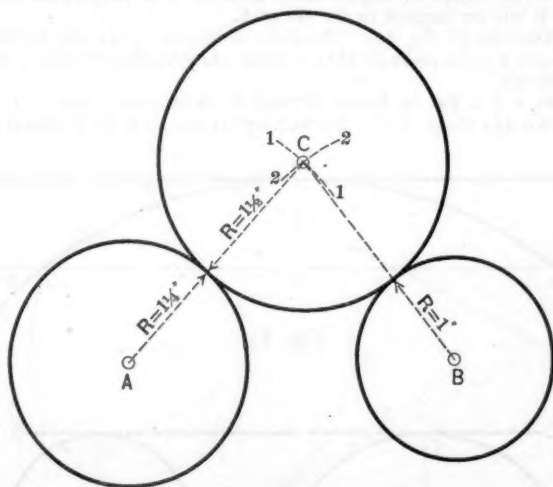


Fig. 92.

D . Join the two points B and C by a straight line BC , and bisect the latter by a perpendicular DE intersecting DA at D . D will then be the center of the required circle, which may be drawn with the radius DB .

PROBLEM 48 (fig. 92). To draw a circle of given radius, excluding each of two given circles, A and B , and touching both of them.

If A and B be the two given circles, and if the given radius $= 1\frac{1}{2}$, then to this radius add that of the circle $A = 1\frac{1}{2}$, or $1\frac{1}{2} + 1\frac{1}{2} = 3$. With this sum as a radius, from A as a center draw an arc 11 ; then add the radius of the circle $B = r'$ to the given radius, or $1\frac{1}{2} + r' = 2\frac{1}{2}$, and with this sum as a radius and B as a center describe an arc 22 intersecting 11 at C . This will be the center of the required circle, which may be drawn with the given radius $1\frac{1}{2}$.

PROBLEM 49 (fig. 93). To draw a circle of a given radius, in-

cluding each of two given circles A and B , and touching both of them.

If A and B be the two given circles, whose radii are $1'$ and $\frac{3}{4}'$ respectively, and the given radius be $2\frac{1}{4}'$, from the latter deduct the radius of A , or $2\frac{1}{4}' - 1' = 1\frac{1}{4}'$. With this remainder as a radius and from A as a center describe an arc 11 . Then

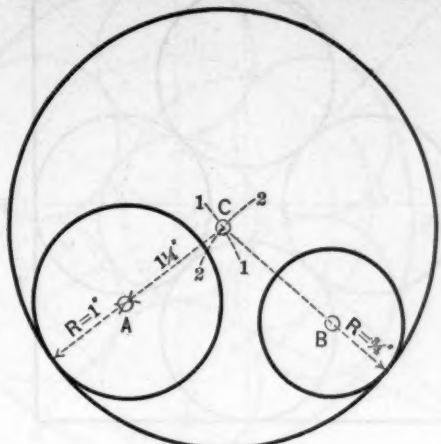


Fig. 93.

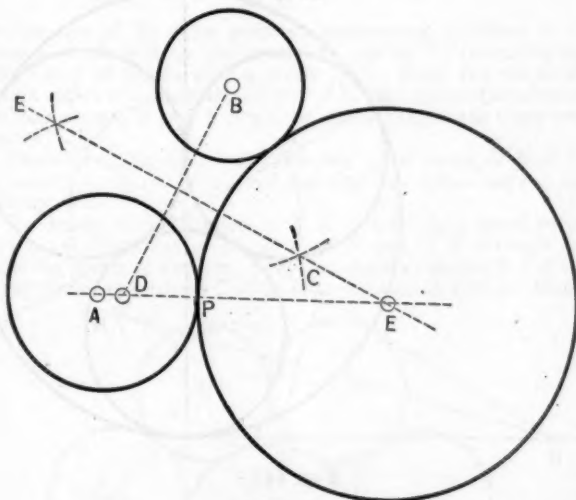


Fig. 94.

from the given radius, $2\frac{1}{4}'$, deduct the radius of $B = \frac{3}{4}'$, or $2\frac{1}{4}' - \frac{3}{4}' = 1\frac{1}{4}'$. With this remainder as a radius and B as a center describe an arc 22 intersecting 11 at C ; this will be the center of the required circle, which can be drawn with the given radius of $2\frac{1}{4}'$ so as to touch and include the circles A and B .

PROBLEM 50 (fig. 94). To describe a circle touching each of two given circles, A and B , externally, and also one at a given point P .

If A and B be the centers of the given circles, and P the given point, from the center A draw the radius AP through P and extend it. From the given point P set off, on the radius AP , a distance PD equal to the radius of the other given circle B . Join the points B and D by a line BD , and bisect it with a perpendicular CE , and extend it until it intersects BP at E . E will then be the center of the required circle, which may be drawn with a radius EP .

PROBLEM 51 (fig. 95). To describe a circle about a given triangle, ABC .

If ABC be the given triangle, bisect any two sides, as AB and AC , by the perpendiculars gh and ef , intersecting each other in the point D . From D as a center and DA as a radius the required circle may be drawn.

PROBLEM 52 (fig. 96). To inscribe a circle in a given triangle, ABC .

If ABC be the given triangle, bisect any two of the angles—as ABC and CAB —by the straight lines AD and BD intersecting in the point D . From D draw a perpendicular, DE , to any side, as AB . Then with D as a center and DE as a radius describe a circle which will touch the three sides of the triangle.

PROBLEM 53 (fig. 97). To inscribe in an equilateral triangle, ABC , the three largest triangles which it will contain, and which will be tangent to each other and to the sides of the triangle.

If ABC be the triangle, draw AG , BF and CE , bisecting the angles and sides of the triangle, and intersecting each

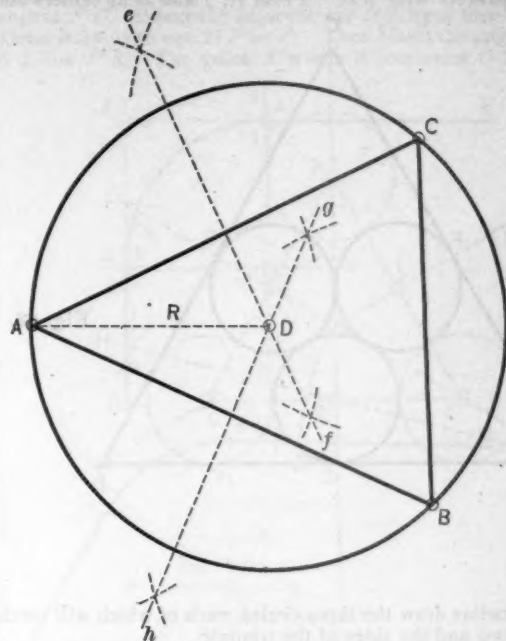


Fig. 95.

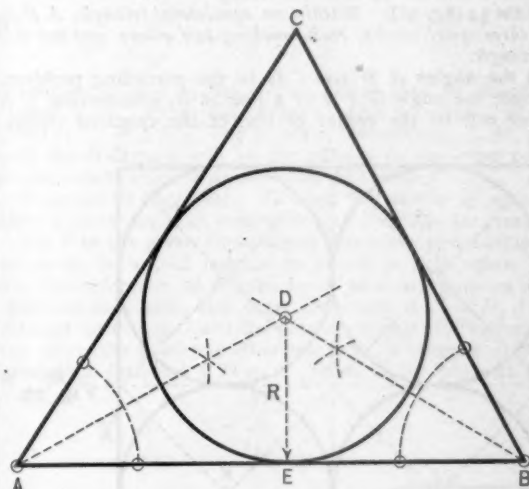


Fig. 96.

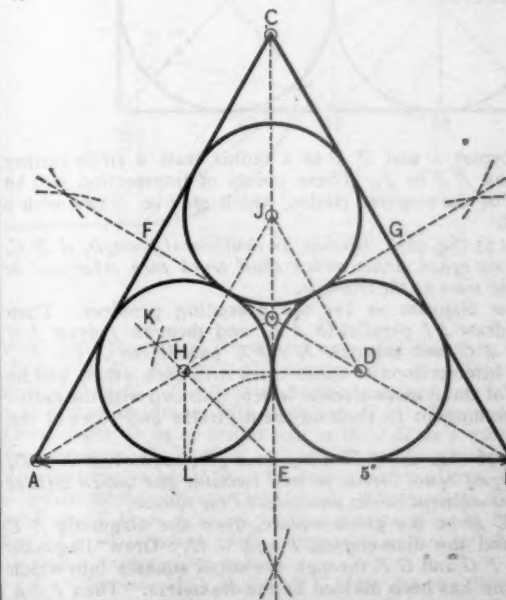


Fig. 97.

other in O . Bisect the right angle AEO by a line EK . Through H , the point of intersection of EK with AO , draw

HL parallel with AB , HJ parallel with AC , and join the points of intersection of HL and HJ with BF and CE by a line JD parallel with CB . From H , J and D as centers and

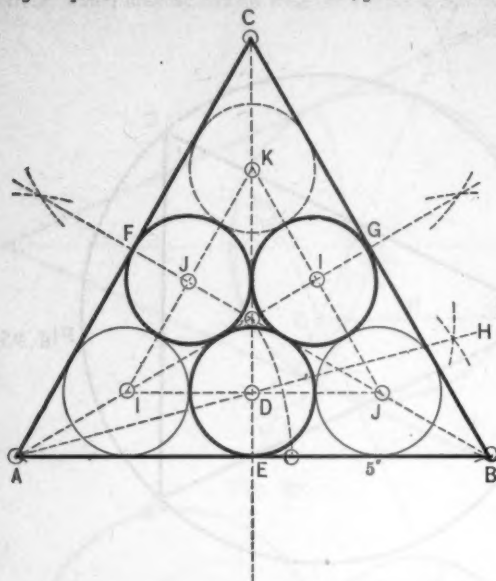


Fig. 98.

With H as a center and HL as a radius draw the three circles, each of which will touch the other two and the sides of the triangle.

PROBLEM 54 (fig. 98). *Within an equilateral triangle, ABC , to draw three equal circles, each touching two others and one side of the triangle.*

Bisect the angles A , B , and C as in the preceding problem. Then bisect the angle GAB by a line AH , intersecting CE at D . D will be the center of one of the required circles.

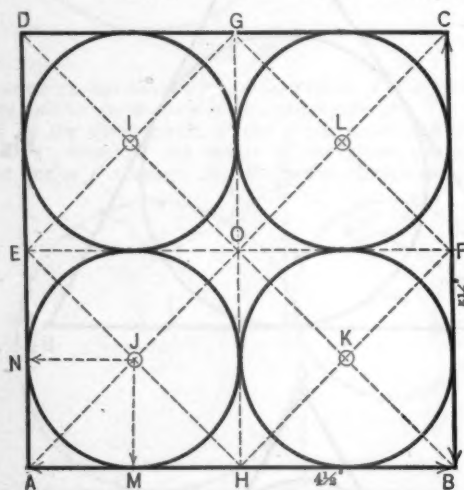


Fig. 99.

From the center O and $O D$ as a radius draw a circle cutting $A G$ in I and $B F$ in J . These points of intersection will be the centers of the required circles, which may be drawn with a radius $D E$.

PROBLEM 55 (fig. 98). *Within an equilateral triangle, ABC , to inscribe six equal circles which shall touch each other and be tangent to the sides of the triangle.*

Draw the diagram as for the preceding problem. Then through D draw IJ parallel to AB , and through J draw JK parallel to AC , and through I , IJK parallel to AC . I , J , and K , the intersections of these lines with each other, will be the centers of three more circles, which, if drawn with the radius DE , will be tangent to their adjacent circles and sides of the triangles.

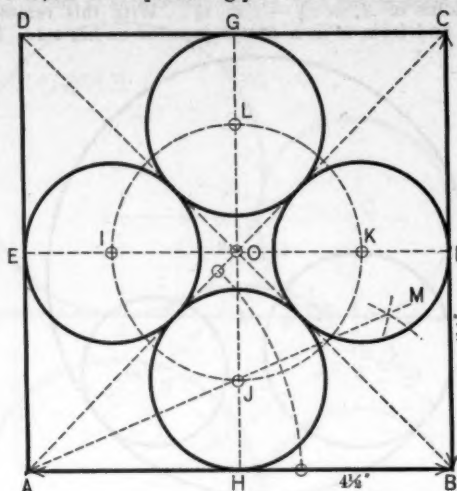
PROBLEM 56 (fig. 99). To draw in a given square, $A B C D$, the three largest equal circles it will contain, and which will be tangent to the adjacent circles and sides of the square.

If $ABCD$ be the given square, draw the diagonals AC and BD and the diameters EF and GH . Draw diagonals EH , HF , FG and GE through the small squares into which the larger one has been divided by the diameters. Then IJK and L will be the centers of the required circles, which may be drawn with a radius JM or LN .

PROBLEM 57 (fig. 100). Within a given square, $A B C D$,

to draw four equal circles, each touching two others and tangent to the middle of the side of the square:

Draw the diagonals AC and BD and the diameters EF and GH , as in the preceding problem. Bisect the angle OAB



F Fig. 100.

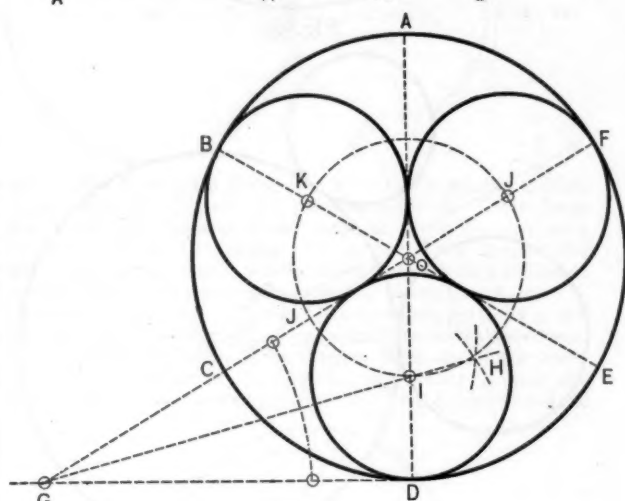


Fig. 101.

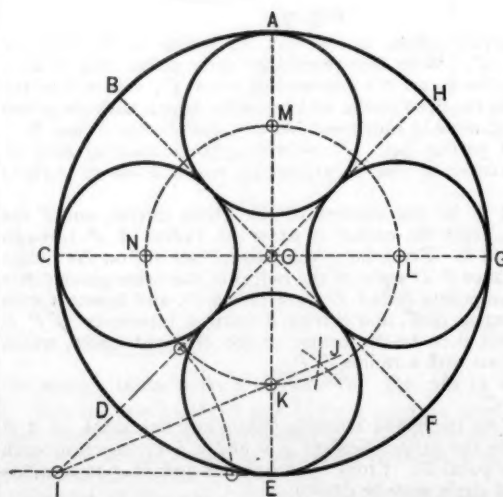


Fig. 102.

by the line AM , cutting GH in J . With a radius OJ and center O draw a circle $JKLI$ cutting the diameter in the points J, K, L and I , which will be the required centers of the circles which may be drawn with the radius JH .

PROBLEM 58 (fig. 101). To draw three equal circles, IJK , in a given circle AEC , which touch each other and the given circle.

With the radius of the given circle divide its circumference into six equal parts, $A B$, $B C$, $C D$, $D E$, $E F$ and $F A$. Through the opposite points of division and the center O of the

circle draw diameters AD , FC and BE . From any of the points of division, as D , where one of the inner circles should touch the given circle, draw a tangent GD and extend an adjacent diameter FC to cut GD at G . Bisect the angle OGD

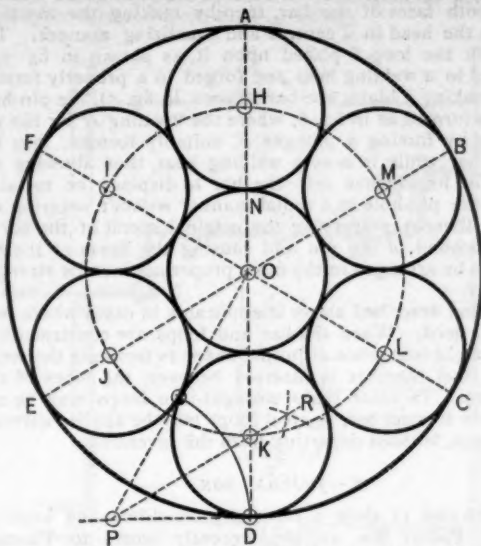


Fig. 103.

by the line GH . The point of intersection, I , where GH crosses AD , will be the center of one of the inner circles, which may be drawn with a radius ID . From the center O , with a radius OI , draw the circle IJK , and where it intersects, the diameters CF and BE will be the centers of the other two circles.

PROBLEM 59 (fig. 102). To draw four equal circles, $M N K L$, in a given circle, $A C E G$, each touching two others and the containing circle.

Divide the circumference, $A C E G$, into eight equal parts, and draw diameters AE , BF , CG and DH through the opposite points of division. From E draw a tangent EI to the given circle, and extend DH so as to intersect EI at I . Bisect

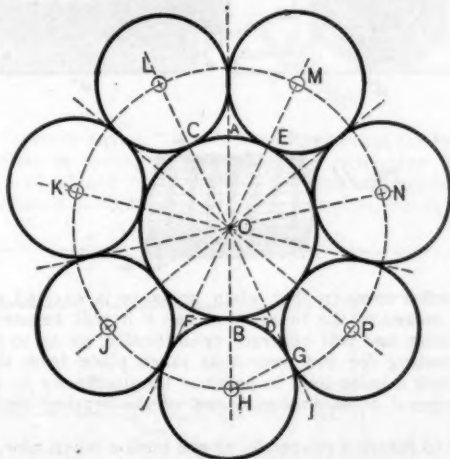


Fig. 104.

the angle OIE by a line IJ . The point K , where IJ crosses OE , will be the center of one of the contained circles, which may be drawn with a radius KE . From O as a center and OK as a radius draw through K the circle $KNML$, and N , M and L will be the centers of the other circles.

PROBLEM 60 (fig. 103). To draw seven equal circles, H, I, J, K, L, M, O , in a given circle, $A B C D E F$.

Let $A B C D E F$ be the given circle. With its radius divide the circumference into six equal parts, and through the opposite points of division draw diameters AD , FC and BE . Divide one of the radii, as OA , into three equal parts—viz., ON , NH and HA . From O , with a radius ON , draw the central circle, and from H as a center, and the same radius, draw the circle AN . From O as a center and OH as a radius draw a circle which, cutting the radii, will give the points I, J, K, L, M . From these points, with a radius $= ON$, draw the other circles, each of which will touch the outside circle, two adjoining others, and the central circle.

PROBLEM 61 (fig. 103). To draw any number of equal circles in a given circle tangent to each other and the given circle.

Divide the circumference of the given circle, $A B C D E F$,

into as many equal parts as there are circles to be inscribed, and draw diameters through the opposite points of division. From the extremity of one of these diameters, as $A D$, draw a tangent $P D$. Bisect the adjacent arc $D E$ by a line $O P$, and extend it so as to cut $D P$ in P . Then bisect the angle $D P O$ by a line $P R$. The point K where it intersects $O D$ will be

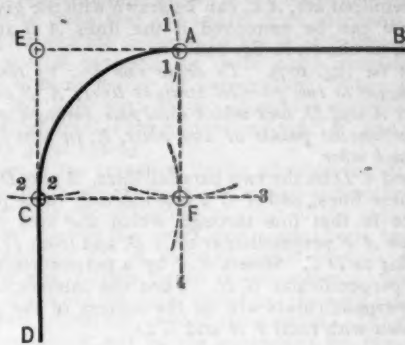


Fig. 105.

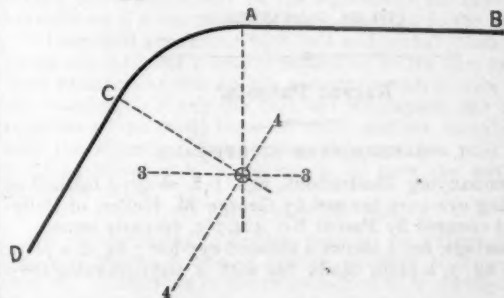


Fig. 106.

the center of one of the circles, which may be drawn with a radius $K D$. From the center O , with a radius $O K$, draw a circle $H I J K L M$. The points of intersection, L, M, H, I, J , with the diameters, will be the centers of the other contained circles, which may be drawn with the radius $K O$.

PROBLEM 62 (fig. 104). To draw any number of equal circles about a given circle, O , tangent to each other and the given circle.

Let O be the given circle about which say seven equal circles are to be drawn, all tangent to O and to each other. Divide the circumference of O into twice as many parts as there are circles to be drawn, and draw diameters AB , CD , EF , etc., through the center O and the opposite points of division. From the extremity B of any diameter draw a tangent $F B D$, and extend the diameter $C D$ to I . From D , the point of intersec-

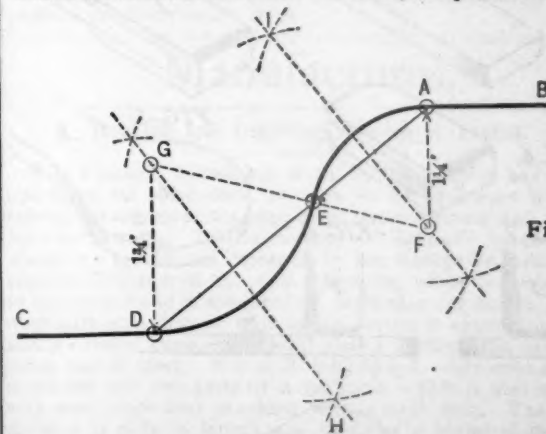


Fig. 107.

tion of the tangent $F D$ with the extended diameter $C I$, lay off $D G = B D$. Draw $H G$ perpendicular to $C I$, meeting $O B$ extended at H . H will then be the center of one of the circles which may be drawn with a radius $H B$. Through H draw a circle from O as a center and with $O H$ as a radius, and its intersections, H, J, K, L, M, N, P , will be the centers of the required circles which may be drawn with a radius $B H$.

PROBLEM 63 (figs. 105 and 106). Having two straight lines, $A B$ and $C D$, at right angles to each other, to unite them with an arc of a circle which shall be tangent to each of the lines and be drawn with a given radius.

First Method.—Let $A B$ and $C D$ be the two lines. Extend them so as to intersect each other at E . From E as a center and the given radius, say $1\frac{1}{2}$, describe arcs 11 and 22 intersecting $A B$ and $C D$ at A and C . With A and C as centers,

and the same radius, draw arcs intersecting each other at *F*, which will be the center from which the required arc *AC* may be drawn with the given radius.

Second Method.—Draw *C 3* and *A 4* parallel to *AB* and *CD* at a distance from them = to the given radius, or $1\frac{1}{4}$ '. The point of intersection *F* of these lines will be the centers from which the required arc, *AC*, can be drawn with the given radius. This method can be employed if the lines *AB* and *CD* are not parallel, as shown in fig. 106.

PROBLEM 64 (fig. 107). To draw two arcs of circles, which shall be tangent to two parallel straight lines, *AB* and *CD*, at given points *A* and *D*, and which shall pass through a line *DA*, meeting the tangent points at any place, *E*, in that line, and be tangent to each other.

If *AB* and *CD* be the two parallel lines, *A* and *D* the given points in these lines, and *AD* a line meeting these points, and *E* the place in that line through which the arcs must pass, from *A* draw *AF* perpendicular to *AB*, and from *D* draw *DG* perpendicular to *DC*. Bisect *EA* by a perpendicular *IF* and *DE* by a perpendicular *GH*. Then the intersections *F* and *G* of these perpendiculars will be the centers of the arcs which may be drawn with radii *FA* and *GD*.

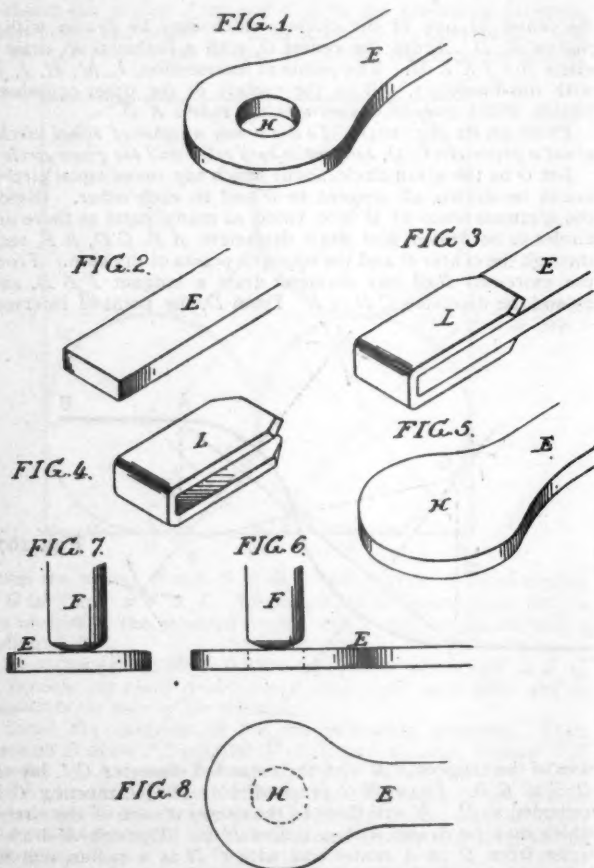
(TO BE CONTINUED.)

Recent Patents.

I.—MANUFACTURE OF EYE-BARS.

THE accompanying illustrations, figs. 1-8, show a method of manufacturing eye-bars devised by George M. Heller, of Philadelphia, and covered by Patent No. 424,783, recently issued.

In the drawings, fig. 1 shows a finished eye-bar; fig. 2, a plain blank bar; fig. 3, a plain blank bar with a strengthening-loop



placed on the end where the head of the eye-bar is to be formed; fig. 4, the strengthening-loop detached from the bar with its ends properly scarfed; fig. 5, a blank eye-bar previous to having the pin-hole formed; figs. 6, 7 and 8 are diagrams showing the manner of forming the pin-hole.

A plain bar *E*, fig. 3, whose fiber is parallel throughout its length, has a loop *L* placed on the end of the bar where the head of the bar is to be formed, the fiber of the loop being parallel to the fiber of the bar and also continuous throughout

its length, and embracing both faces of the bar *E*. This disposition of the additional metal in the loop *L* required to form the head of the bar is chosen because of its providing a large welding surface between the bar and the loop, and it is made to embrace both faces of the bar, thereby making the metal to strengthen the head in a central and equalizing manner. The bar *E*, with the loop *L* placed upon it, as shown in fig. 3, is then heated to a welding heat and forged in a properly formed die, thus making a blank eye-bar (shown in fig. 5), the pin-hole of which is formed as in fig. 6, where the opening *H* for the pin *P* is made by forcing a plunger *F*, suitably formed, into the blank eye-bar while it is at a welding heat, thus allowing the plunger *F* in its advance into the bar to displace the metal of the bar at the pin-hole in a radial manner without severing the fibers, and thereby preserving the original metal of the bar in the neighborhood of the pin and causing the fibers of the finished bar to be arranged in the most proper manner for strength and security.

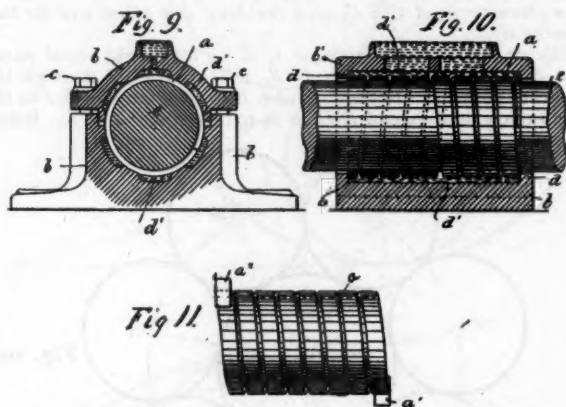
The method described above is applicable in cases where iron is the metal used. When the bar and loops are constructed of steel, a wrought-iron plate of proper shape to facilitate the welding of the steel together is inserted between the faces of the bar and loop. In some cases wrought-iron loops may be applied directly to steel bar, or steel loops may be applied directly to an iron bar, without departing from the invention.

II.—JOURNAL-BOX.

Figs. 9, 10 and 11 show a form of journal-box and bushing covered by Patent No. 425,569, recently issued to Thomas Gare, of Stockport, England.

Fig. 9 is a sectional end view of the bush and bearing. Fig. 10 is a longitudinal section of the bearing, showing the bush partly in section and partly in view. Fig. 11 is a side elevation of the bush detached.

The bush *a* consists of a flat metal bar coiled into a hollow cylinder and inserted in the box *b*, which is furnished with a



cap *b'* in such a manner that when pressure is exerted on the bush *a* by means of the bolts *c* and cap *b'* it will be prevented from revolving and will contract cylindrically, so as to permit of compensating for the wear that takes place from time to time, the bush *a* being held in position longitudinally by means of the flanges *d*, formed at each end of the bearing and cap *b* and *b'*.

In order to insure a proper fit of the bush *a* when new, without applying pressure thereon, the interior diameter is made a little less than the diameter of the shaft *e*, to which it will be applied.

On the sides of the bush *a* one or more cavities *d'* are formed in the bearing *b*, which serve as receptacles for the lubricant, whence it supplies itself to the interior of the bush *a* by passing between the coils of the same.

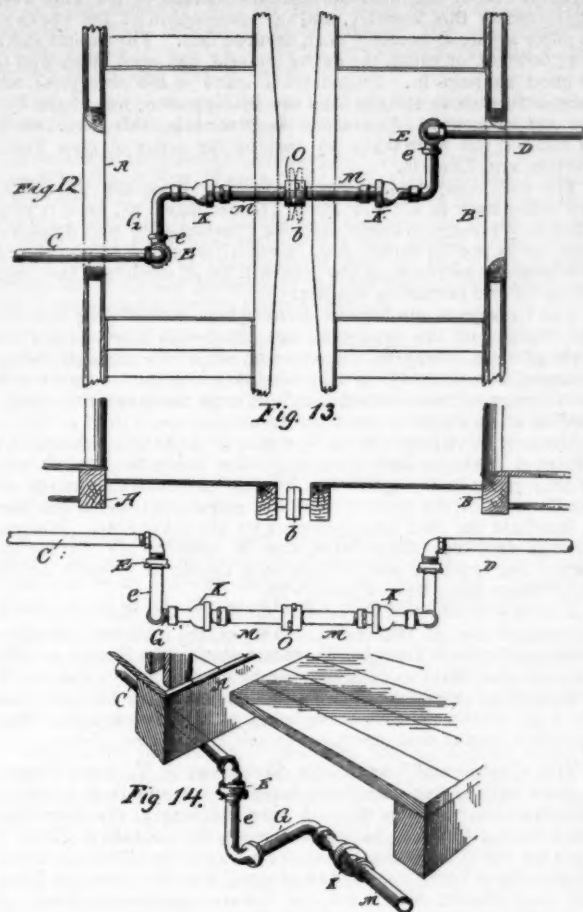
The arms or lugs *a'* *a''* may be provided with set-screws by which the bush may be contracted or expanded to insure a proper fit.

III.—CAR-HEATING APPARATUS.

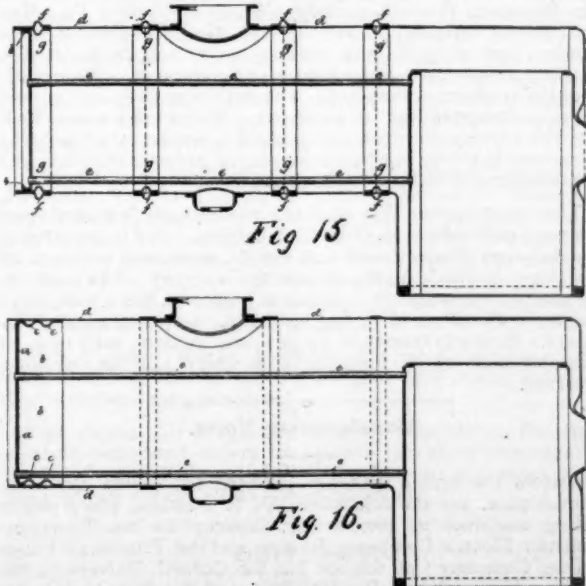
Figs. 12, 13 and 14 show an improvement in car-heating apparatus invented and patented by William Buchanan, of New York, the patent being No. 424,459. Fig. 12 is a bottom view of the ends of two cars with the invention attached; fig. 13 is a side view, and fig. 14 is a perspective view.

This is a joint or coupling for a continuous heating apparatus, and is intended to complete the connection between the cars. In the cuts *A* and *B* are the sills of the two cars and *b* the buffers. The main lines of steam pipe are shown at *C* and *D*. At *E* is a swivel-joint, *e* is a pipe extending down from it; *G* is a cross

pipe, which is attached by a coupling to a ball-and-socket joint at *K*. The latter carries the connecting pipe *M* which terminates in the coupling *O*, which connects to the similar coupling on the adjoining car, as shown. The general action will be readily understood from the engravings.



The inventor says: "It will be observed that the swivel-joint mechanism is arranged vertically, the cross-pipe is at right angles and placed horizontally, and the ball-and-socket-joint mechanism is at right angles to the cross-pipe, but is preferably



in the same horizontal plane. By reason of the ball-and-socket-joint mechanism the connecting-pipe *M* can be adjusted at any desired angle, so that its coupling can be attached to the one of the other car without difficulty, and when the cars are in motion the coupling-pipe can assume all necessary angles. The motion

between the cars, due to their approaching and receding from one another, is allowed for by the swivel-joint and the cross-pipe *G*. As the cars approach, the swivel-joint comes into play, the cross-pipe moves in an arc, and the motion of the car is thus allowed for. As the cars recede, the same thing takes place, only the cross-pipe moves in the opposite direction.

"It will be seen that the swivel-joint mechanism supports the cross-pipe and the ball-and-socket-joint mechanism without requiring special supports for these parts from the car-body, which is a difficult matter to accomplish. When the cars are separated, the only part of the apparatus which hangs down toward the ground is the connecting-pipe *M*, and this cannot drop to any great extent.

"The gist of the invention lies in allowing for all the various motions using a swivel-joint and a ball-and-socket joint, the swivel-joint being so related to the rest of the apparatus that it supports and carries the pipes and connections between itself and the coupling *O*. A ball-and-socket joint in place of the swivel-joint would allow for all the movements; but when the cars were separated the parts would not be held positively, and some of them would fall toward the ground. Thus a ball-and-socket joint would not be the equivalent for the swivel-joint here shown if it occupied the same position in the combination.

"I am well aware that both ball-and-socket joints and swivel-joints are old; but I believe myself to be the first to so arrange them under a car that all the necessary motion can be made by the coupling. When the cars are uncoupled, the swivel-joint supports all the parts between itself and the coupling. In this way the attendant in coupling the cars has only to lift the coupling-pipes, and, if necessary, to turn the swivel-joint to effect the union."

IV.—LOCOMOTIVE BOILER.

An improvement in boilers, covered by Patent No. 423,406, issued to Martin Atock, of Dublin, Ireland, is shown in figs. 15 and 16. It consists in the introduction of a corrugated plate in the barrel of the boiler to provide elasticity and prevent undue strain from expansion and contraction. This may be done, as shown in fig. 15, by making the boiler with butt-joints and using corrugated joint-strips *fff*. In this case each joint strip *f* has a corrugated cover *g*, of non-corrosive metal, to prevent pitting.

Another method, shown in fig. 16, is to form the tube-plate *a a* with a deep flange *b*, in which are two corrugations *cc*. The tube-plate and its flange lie completely within the barrel *d*, to which the flange is riveted at its edge; *eee* represent the tubes, which are secured at the ends in any suitable manner. As the tubes expand relatively to the shell, either owing to their attaining a greater temperature or being formed of a metal having a higher coefficient of expansion, the corrugations *cc* become flatter and allow the tube-plate *a* to take up a new position relatively to the shell.

Manufactures.

Heating and Lighting Passenger Trains.

THE Chicago, Milwaukee & St. Paul Company has had in operation for some time, on one of its passenger trains, a special arrangement for supplying steam heating and electric light to the train. This is done by a "light and heat tender," which is a special car designed by Mr. George W. Gibbs, Mechanical Engineer of the road. This car, which is carried next to the tender and is mounted on passenger car trucks, has an unusually strong floor framing to protect it against accident, and is covered outside with steel plate $\frac{1}{2}$ in. thick, the end doors being also of steel. It is 34 ft. long by 9 ft. wide over all, and is divided into two parts by a partition, which is also covered with steel plate and provided with a steel door. The larger division is 20 ft. in length, and contains a boiler of the locomotive pattern, which supplies steam for heating the train and also for running the engine in the other compartment. Back of the boiler are placed the coal boxes, one on each side, leaving room between them for the fireman. The water supply is drawn from the locomotive tender. In the smaller division of the car is a Westinghouse engine of 15 H. P., which runs an Edison dynamo. This dynamo is connected with a switch-board from which wires are carried to the cars for the electric lights. The engine and dynamo are placed on one side of the car and their weight is balanced by a tank placed on the other side, in which is carried a supply of water for the boiler, which can be drawn upon when the engine is detached, or in case any accident should happen to the couplings connecting with the locomotive tender.

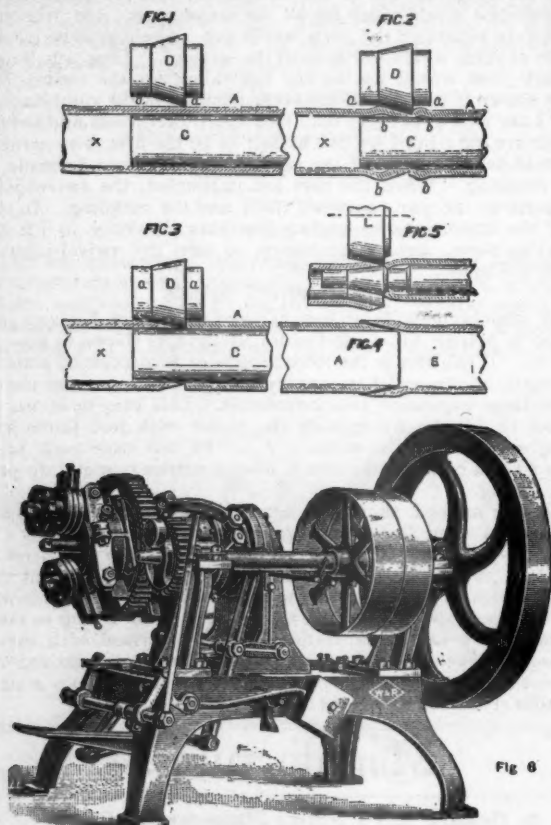
When the car was first placed in use a set of storage batteries was carried, in case the engine or dynamo should break down,

but this has been found unnecessary, and the batteries are no longer carried.

The system has been found to work very well. In the summer time, when it is not necessary to heat the train, the special car is laid aside and the dynamo and engine placed in the baggage car, steam being supplied to the engine from the locomotive boiler.

The Hartz Tube Welding Machine.

THE machine illustrated by the accompanying engraving has been made for the purpose of cutting, preparing, piecing, and welding tubes, more especially such tubes as are used in locomotive and other boilers and require renewing at one or both ends, after wear. The machine is provided with a series of cutting and forming rollers, which are shown in figs. 1 to 5, which are diagrams intended to explain the action rather than



show the precise form of the rollers. Fig. 6 is a perspective view of the machine, showing the position of the rollers and the mandril upon which the tubes are cut, formed, and afterward rolled, when the joint is placed upon it at a welding heat. In fig. 1, C represents the mandril of the machine, and D one of the cutting and forming rollers, about to be forced into the tube as it rolls round it. Fig. 2 shows the same roller and tube after the roller has forced its way half through the thickness of the tube. Fig. 3 shows respective positions, and the form of the tube end when the bad piece has been severed from the main part, and the roller just touching the mandril. This part of the work being done, it is necessary to give the end of the piece of the new tube which is to be welded to it the form of the part marked B on fig. 4. For this purpose the roller D is changed for one with less taper, and, as shown in fig. 5, the mandril, which is movable, is changed end for end, the form of the end required for this purpose being as shown. By working it on this taper mandril, the end of the piece of tube is tapered outward, as shown in fig. 5, and the two pieces of tube now fit together, as shown in fig. 4. A number of tubes being thus prepared, the suitable cylindrical rollers are placed in the machine, the mandril changed so that its cylindrical part is under the path of the rollers, and the tubes at a welding heat are placed on the mandril and worked by the revolving action of the roller which runs round the tube, consolidates the weld and gives the tube the proper thickness.

The machine is made and introduced by Woodhouse & Rawson, of London, and is in use in several large railroad shops.—*The London Engineer.*

Marine Engineering.

THE new syndicate which has purchased the land for an immense shipbuilding plant on the Delaware River below Mifflin Street is one of the most substantial concerns of the kind ever organized in this country, and the completion of the works at as early a date as possible is an assured fact. The capital stock is \$5,000,000, of which the entire amount has been taken and is as good as paid in. Philadelphia leads in the enterprise not only in furnishing the site and the leading men, but of the \$5,000,000 subscribed \$2,000,000 is placed in this city, while \$1,000,000 has been taken in each of the cities of New York, Boston, and London.

The tract comprises 60 acres, extending from the Port Warden's line back to the old Point House Road, or, as it is now known, Weccacoe Avenue, and the consideration was \$300,000 cash, or \$5,000 an acre. A payment of \$100,000 was made on Wednesday, and at least 500 men will be at work in a few days filling in and preparing the site.

The Cramps of the famous Kensington shipbuilding firm are the nucleus of the syndicate, and their idea is to transfer all their present works to the new site, while the Lehigh Valley Railroad Company will in all probability buy the land on which the Cramps are now situated, as it adjoins the property recently purchased by them on the river front.

Much of the success of the new enterprise has been due to the efforts of Wharton Barker, who, besides being largely interested personally in the syndicate, has had the practical charge of the finances of the venture, and his recent trip to Europe was to conclude the final arrangements on the other side. Matters were in excellent shape here, and as soon as Mr. Barker returned the business was brought to a climax as speedily as the legal forms could be complied with.

The new plant will be beyond all doubt the shipyard of the country, if not of the world. One of its features will be an immense dry dock capable of accommodating the largest vessels afloat or that may be designed for years to come. The site is admirably adapted for shipbuilding because of its location and the depth of the channel, there being 30 ft. of water at the Port Warden's line at that point.—*Philadelphia Record*, June 6.

THE Continental Iron Works, Brooklyn, N. Y., have recently filled orders for corrugated furnaces for boilers as follows: 56 furnaces for cruisers 7 and 8, now building at the Brooklyn Navy Yard; 8 for the boilers of the new fire-boat *New Yorker*; 2 for the lighthouse tender *Azalea*; 16 to the Quintard Iron Works, New York, for the new cruiser, No. 11; 16 to the Morgan Iron Works, New York, for the steamer *Rhode Island*; 8 to the Union Iron works, San Francisco, for the steamer *City of Panama*; 2 to the Lake Erie Boiler Works, Buffalo, N. Y.; 3 to the Atlantic Iron Works, Boston; and 5 to M. T. Davidson, for the new boilers for the Brooklyn Water Works.

THE new steamer *Seguranca* was launched from the yard of the Delaware River Shipbuilding Works at Chester, Pa., May 17. She is intended to run between New York and Rio de Janeiro, and is 336 ft. long over all, 45 ft. 6 in. beam, 27 ft. 9 in. deep to spar deck, and 4,890 tons displacement. The engine is of the triple-expansion type, with cylinders 30 in., 46 in. and 74 in. in diameter and 48 in. stroke. There are six steel boilers with corrugated furnaces, intended to work at 160 lbs. The *Seguranca* has very handsome passenger accommodations, and is provided with electric lights throughout.

THE new steamer *City of Seattle* was recently launched from the yard of Neafie & Levy in Philadelphia. She is intended to run between Puget Sound and Pacific ports, and is owned by the Puget Sound & Alaska Steamship Company. She is 260 ft. long, 40 ft. beam and 17 ft. depth of hold, and has a compound engine, with cylinders 32 in. and 60 in. in diameter and 36 in. stroke. Steam is furnished by two steel boilers, each 13 ft. in diameter and 14 ft. long, built to carry 140 lbs. working pressure.

Manufacturing Notes.

AMONG the orders recently received by Riehle Brothers, Philadelphia, are the following: U. S. standard screw-power testing machines of 200,000 lbs. capacity for the Thomson-Houston Electric Company, Boston, and the Pittsburgh Forge & Iron Company; of 100,000 lbs. for Cornell University, the Western University of Pennsylvania, and the State University of Iowa; of 40,000 lbs. for the University of West Virginia. A horizontal testing machine of 200,000 lbs. capacity for the Gould Steam Forge Company, Buffalo, N. Y. Wire testers, 10,000 lbs. capacity, for the Thomson-Houston Electric Company; of 5,000 lbs. for Smith & Egge, Bridgeport, Conn. A

torsional testing machine of 5,000 lbs. capacity for the Thomson-Houston Company. Foundry testers of 5,000 lbs. capacity for the Keely Stove Works, the East Chicago Foundry, and the United States Rolling Stock Company. A testing machine for Coleman Sellers, Philadelphia. A cement tester, 1,000 lbs., to go to Charleston, W. Va., for the United States Government. Smaller orders include a large number for rope-twisters, marble-moulding machines, Robie screw-jacks, railroad scales, wagon scales, and smaller work.

THE American Bridge Works at Roanoke, Va., are building three iron draw-spans for the Norfolk Southern Railroad.

THE Haberkorn Brake Company has had a train of 25 freight cars fitted up at Fort Wayne, Ind., with the Haberkorn brake. This train will be used to illustrate the merits of the brake to railroad officers. The advantages claimed for it are an improved lever system, a very simple and elastic driver brake, full control given to the operator, and the use of a governor which limits the air pressure in the car cylinder and increases the pressure according to the load carried.

THE Fontaine Safety Signal Company, of Detroit, has had one of its signals in operation on the Michigan Central Railroad for nearly a year, and another on the New York Central & Hudson River near Spuyten Duyvil since last January. The signal in both cases meets with approval. Its object is to indicate to the engineer of a passing train the length of time which has elapsed since the preceding train passed. It is operated by the wheels of the train, and will indicate the time up to 20 minutes at each operation.

A SAFETY running-board, provided with railings and intended to prevent accidents to brakemen on the top of freight cars, has been invented by Francis W. Pool and Thomas N. Young of St. Paul, Minn., who are now introducing it.

THE Electric Merchandise Company, of Chicago, has bought the merchandise business of the Sprague Electric Equipment Company and will manufacture appliances of all kinds for electric railroads of all systems, including many improvements in car fittings, line material, etc.

THE South Boston Iron Company has decided to move its plant from Boston to Middlesboro, Ky. The removal will be made gradually, and the reason given for it is that the Company will secure a great reduction in cost of fuel, iron ore, etc. The South Boston Works have been engaged for a number of years in building heavy machinery, and during the war and since have also done a large business in casting of heavy guns for the Government.

Cars.

THE Scarritt Furniture Company, St. Louis, is furnishing its improved No. 34 seats for 24 new passenger cars for the Texas & Pacific Railroad; also the seats for 12 very handsome new passenger cars which the Harlan & Hollingsworth Company and the Ohio Falls Car Company are now building for the Louisville & Nashville Railroad. The Company has also received orders for Scarritt reclining chairs to fit up some very handsome chair cars which the Atchison, Topeka & Santa Fé Company is building in its shops in Topeka, Kan.

THE shops of the United States Rolling Stock Company in Anniston, Ala., have orders for 300 box cars for the Savannah, Americus & Montgomery; 300 coal cars for the East Tennessee, Virginia & Georgia, and 200 flat cars for the Montgomery, Tuscaloosa & Memphis Railroad. The shops of the company at Hegewisch, Ill., are building 90 caboose cars and 500 fruit cars for the Union Pacific Railroad. Of the fruit cars 100 are to be fitted to run on passenger trains.

THE Pullman Works, Pullman, Ill., are delivering a large number of coal cars to the Philadelphia & Reading Railroad. The order was for 4,000 cars.

THE Pardee Car & Machine Works, Watsonstown, Pa., have recently completed orders for 250 box cars of 25 tons capacity for the Central Railroad of New Jersey, and a number of 30-ton coal cars for the Beech Creek Railroad.

OBITUARY.

FRANCIS C. LOWTHORP, who died in Trenton, N. J., June 1, aged 81 years, was well known as an engineer of many years' standing and one of the earliest builders of iron bridges in this country. At his works in Trenton he made many turn-tables and a number of bridges—most of the latter on a plan devised

by himself, with cast-iron posts and top chord and a bottom chord of iron plates. The bridges on the Newark Branch of the Central Railroad of New Jersey were of this type. Mr. Lowthorp was a Fellow of the American Society of Civil Engineers.

FRANK A. LEERS, who died in Paterson, N. J., May 19, aged 46 years, was a native of Prussia, and received his early training as an engineer in that country. He came to this country in 1871, and was for several years in St. Louis, being employed on the St. Louis Bridge, at the Carondelet Furnace, and on city work under Colonel Flad. In 1878 he came to New York as Assistant Engineer on the Manhattan Elevated, and in 1880 was appointed Engineer of the Bridge Department of the Passaic Rolling Mill Company, a position which he held until his death.

CHARLES ACKENHEIL was killed in an accident on the Baltimore & Ohio Railroad near Childs, Del., June 19, the car in which he was riding being derailed. Mr. Ackenheil was an engineer of standing and experience, and had been for some time Chief Engineer of the Staten Island Rapid Transit Company. He was born in Baden-Baden in 1842, and was a graduate of Heidelberg University. He came to this country when he was about 19 years of age. He was a member of the American Society of Civil Engineers, built the bridge over the Monongahela for the Wheeling & Pittsburgh Railroad, and was one of the designers of the Arthur Kill Bridge. He had been connected with the Baltimore & Ohio Company for 20 years, and when, in 1885, that Company became interested in the Staten Island Rapid Transit Company he was appointed its Chief Engineer. When the accident occurred he was traveling on official business for the Company.

PERSONALS.

JOHN PLAYER has been appointed Superintendent of Motive Power of the Atchison, Topeka & Santa Fé Railroad. He was lately on the Wisconsin Central.

WILLIAM MILLER, late of the St. Louis, Vandalia & Terre Haute, has been appointed Superintendent of Motive Power of the Columbus, Hocking Valley & Toledo Railroad.

E. F. C. DAVIS, late Mechanical Engineer of the Philadelphia & Reading Coal & Iron Company, is now General Manager of the Richmond Locomotive & Machine Works at Richmond, Va.

HARVEY MIDDLETON has been appointed Superintendent of Motive Power of the Union Pacific Railroad. He was formerly on the Louisville & Nashville and more recently on the Atchison, Topeka & Santa Fé.

FRANK L. SHEPPARD has been appointed General Superintendent of the Pennsylvania Railroad Division of the Pennsylvania Railroad, succeeding Robert E. Pettit, resigned. Mr. Sheppard has been on the road for 22 years, serving in various grades; for eight years past he has been Superintendent of Motive Power of the Pennsylvania Railroad Division. His successor in the last-named office is J. M. WALLIS, who has served 13 years on the road, holding various positions in the Motive Power and Operating departments.

GEORGE W. CUSHING has resigned the position of Superintendent of Motive Power of the Union Pacific Railroad, to which he was appointed in February, 1889. He is for the present residing in Chicago. Mr. Cushing has had experience on many important roads, having had charge of the machinery department on the Kansas Pacific, the Wabash, the Missouri, Kansas & Texas, the Northern Pacific, and the Philadelphia & Reading, before going to the Union Pacific. He also served on the Chicago & Northwestern for a number of years.

PROCEEDINGS OF SOCIETIES.

National Conference of Railroad Commissioners.—The second yearly conference of Railroad Commissioners met in Washington, May 28, nearly all the State commissions being represented. Judge Thomas M. Cooley, of the Interstate Commission, was chosen Chairman; Commissioner E. P. Jervey, of South Carolina, Vice-Chairman, and Mr. Edward A. Moseley Secretary. Judge Cooley made a short address.

The Committee appointed last year made a report on Means for Securing Harmony in Railroad Legislation. The report set forth the necessity for harmony, and presented resolutions which were finally passed, with some amendments, as follows:

"Resolved, That it is expedient that the laws of the several States should be in harmony with the laws of the United States on the following topics:

"The definition and prohibition of unjust discrimination.
 "The prohibition of undue and unreasonable preferences and advantages.
 "The requirement of equal facilities for the interchange of traffic.
 "The regulation of the relations between rates of compensation to be allowed for long and short hauls.
 "The regulations as to printing and posting rates, fares and charges.
 "The regulations as to notice to be given of advances and reductions in rates.
 "The penalties for false billing, false classification, false weighing, etc.
 "Resolved, That the respective States should require either directly by law, or indirectly through the instrumentality of their railroad commissions, each railroad corporation subject to their jurisdictions to place driving-wheel brakes and apparatus for train brakes upon every locomotive hereafter constructed or purchased by it, and train-brakes upon every train, and also place upon every freight car hereafter constructed or purchased by it and upon every freight car owned by it, or the coupler or drawbar of which is repaired by it, an automatic coupler of the M. C. B. type at each end of the car.

"Resolved, That Congress either directly by law or indirectly through the instrumentality of the Interstate Commerce Commission should take similar action."

On the second day the various questions prepared by the Committee were taken up for discussion. On Regulating Railroad Construction a committee was appointed to consider the question of securing some uniform legislation. On State Railroads a committee was also appointed to consider how they could be brought under the interstate law.

Reasonable Rates were discussed at length, and a committee appointed to report next year.

On Annual Reports the Committee appointed last year presented a report, which was discussed at length and finally referred back, with instructions to prepare a report on the whole subject of reports and accounts.

On Classification of Freight there was a long discussion, in which the importance and great convenience of a uniform classification for the whole country were strongly used.

It was resolved that the next conference be held in Washington, on the first Wednesday in May, 1891, and the Convention then adjourned.

Master Car-Builders' Association.—The 24th Annual Convention began at Old Point Comfort, Va., June 10. President McWood delivered his annual address congratulating the Association on the progress made during the past year. The Secretary's report showed that there are now 141 active, 100 representatives and 6 associate members, making a total of 247. The number of cars represented is 911,417, an increase of over 100,000 during the year.

On the first day reports were presented by the Committees on Standard Marking of Freight Cars; on Best Material for Brake Shoes; on Steam Heating and Ventilation; on Passenger Cars; and on the Rules of Interchange. The report on Brake Shoes contained an account of the tests made under charge of the Committee, but was not a final one. The report on Steam Heating gives evidence of much progress in that direction, but was also not a final one. The two committees were continued until next year. All these reports were discussed by the Convention.

The second day was devoted to the discussion of the Rules of Interchange, in which a number of slight changes were suggested by the Committee and by others.

A large number of supply firms were represented at the Convention by exhibits of their productions.

On the third day reports were presented by the Committees on Journal box, Bearing and Lid for 60,000-lbs. Cars; on Steel Plate and Malleable Iron in Car Construction; on Loading Bark and Logs on Cars; and on Height of Draw-bars for Passenger Cars. All of these reports were discussed.

The recommendations of the Committees on Height of Draw-bars and on Standard Fittings and Couplings for Steam Heating were ordered referred to letter-ballot.

For the place of meeting for next year a majority of votes favored Cape May.

The officers elected for the ensuing year are: President, John Kirby, Cleveland, O. Vice-Presidents, E. W. Grieves, Baltimore; John S. Lentz, Packerton, Pa.; T. A. Bissell, Buffalo, N. Y. Treasurer, G. W. Demarest, Baltimore. Members of Executive Committee, J. N. Barr, Milwaukee, Wis.; W. H. Day, Florence, S. C.; J. W. Marden, Boston. John W. Cloud was re-elected Secretary.

Master Mechanics' Association.—The 23d Annual Convention began at Old Point Comfort, Va., June 17, with a large attendance. An address of welcome was delivered by Mr. M. E. Ingalls, after which Mr. R. H. Briggs delivered his annual address as President. The Treasurer reported a balance of \$1,081 on hand. The Secretary reported a total of 363 members, of whom 334 are active, 15 associate, and 14 honorary members.

A resolution was passed authorizing the appointment of a committee to arrange for the investment of the Boston fund in scholarships at the Massachusetts School of Technology, the Stevens Institute, and Cornell University.

The questions for discussion offered on the first day were the Method of Fitting Bolts; and Is It Safe to Run a Pony Truck under Fast Express Trains? The Committee on Compound Locomotives presented its report.

On the second day this report was discussed. The Committee on the Establishment of Testing Stations presented no report, and was continued until next year. Reports were also presented by the Committees on Position of Fire-box, and on Steel and Iron Axles.

On the third day the remaining committee reports were presented and discussed. An abstract of these reports will be found elsewhere in this number.

The remainder of the third day's sessions was devoted to the transaction of the usual routine business. It was decided to appoint a committee to confer with a similar committee from the Master Car Builders' Association to make arrangements, by which the meetings of both associations can be held at the same place, and the time so arranged as to require less than the two weeks' attendance which must now be given by those who are members of both associations.

The following officers were elected for the ensuing year: President, John Mackenzie, Cleveland, O.; First Vice-President, John Hickey, Kaukauna, Wis.; Second Vice-President, William Garstang, Richmond, Va.; Treasurer, O. Stewart, Boston, Mass.; Secretary, Angus Sinclair, New York.

American Society of Railroad Superintendents.—The officers now are: President, C. S. Gadsden, Charleston, S. C.; Secretary, C. A. Hammond, 350 Atlantic Avenue, Boston, Mass. The annual meeting will be held in New York on the day preceding the fall meeting of the General Time Convention.

American Water Works Association.—The annual convention began in Chicago, May 21, and continued for three days. The sessions were well filled up with the reading of papers and with discussions.

Among the papers read and discussed were included the following subjects: Hydrants, by Edwin Darling; Book-keeping for Water Departments, by J. P. Donahue; Water Power of Rock River, Michigan, by S. McElroy; Basis for Schedules of Water Rates, by J. N. Tubbs; Water Supplies, by C. Monjeau; Public Filtration, by J. J. Caldwell; Water Rates, by C. N. Priddy; Water Meters, by J. H. Decker; Pumping Machinery, by Charles A. Hague; Artesian Wells, by J. T. Lakin; Water Works Construction, by F. L. Fuller.

The following committees were appointed, to report to the next convention: On Water Supplies, A. R. Leeds, J. L. Le Conte and L. H. Gardner. On Specifications for Cast-iron Pipe, T. W. Yardley, S. B. Russell and A. J. Guilford.

The annual banquet of the Association was given on the evening of May 22. On the morning of May 23 the members visited the water works at Elgin and afterward the city of Pullman.

The officers chosen for the ensuing year are: President, William B. Bull, Quincy, Ill. Vice-Presidents, G. H. Benzenburg, Milwaukee, Wis.; J. A. Barnes, Chicago; I. L. Lyman, Lincoln, Neb.; R. M. Ellis, Boston; H. F. Dunham, Cleveland, O. Secretary and Treasurer, J. M. Diven, Elmira, N. Y.

The next convention will be held in Philadelphia in April, 1891.

American Society of Mechanical Engineers.—The Society has occupied its new house at No. 12 West Thirty-first Street, New York City, which is thus described in a circular issued by Secretary F. R. Hutton:

"The Society will occupy the parlor at the right of the entrance as its business office and members' rendezvous, and the library will be on the second floor. This second floor has been fitted up by its former owners as a library area, and has a capacity for 20,000 volumes. As the present library of the Society numbers less than 2,000 volumes, it will be seen that there is room for abundant growth. The second story small front

room will be the Secretary's private office. The third story rear room will be used as a room for photographs, drawings, and collections of models and apparatus, and in this room, with a sunny southern exposure, will be kept a drawing table and usual instruments for the use of non-resident members who may find such an outfit a convenience when in the city. The incandescent electric light is to be put into the building throughout, which will add very much to the comfort of every one, particularly of readers at night and in warm weather.

"Back of the entry and parlor-office on the ground floor is the large auditorium, two stories in height, with seating capacity for over 200, electrically lighted and ventilated by mechanical means. This auditorium to be redecorated, and new and more comfortable seats are to be put into it. The telephone service will be provided as heretofore, for the convenience of the members.

"The house is 28 ft. 4 in. wide, and is 175 ft. west of Fifth Avenue. The house and lot cost \$60,000. Of this sum, \$33,000 are left on bond and mortgage by its former owners, and the balance was subscribed for and loaned by interested members of this Society. Considerably more has been subscribed than is actually needed, although not enough to clear off the mortgage entire."

American Institute of Electrical Engineers.—The annual meeting was held in New York, May 20, when the reports showed that there were now 427 members, and that the Institute was in a very prosperous condition.

The officers elected for the ensuing year were as follows: President, W. A. Anthony, Manchester, Conn. Vice Presidents, Francis B. Crocker, Frank J. Sprague and Joseph Wetzel, New York. Managers, P. B. Delany, South Orange, N. J.; Horatio A. Foster and J. C. Chamberlain, New York. Treasurer, George M. Phelps. Secretary, Ralph W. Pope, New York. The officers of the Institute are now at No. 12 West Thirty-first Street, New York.

On the following day a meeting was held in Boston, at which a number of papers were read. The meeting closed with a dinner in the evening.

American Society of Civil Engineers.—At the regular meeting, May 21, there was a general discussion on Cement, in which notes of experience were presented by Messrs. Gould, Bates, Collingwood, Worthen, Buck, Brush, Crowell, Odell and others, many interesting points being brought forward.

At the regular meeting in New York, June 4, the death of F. C. Lowthorp, Fellow of the Society, was announced.

Mr. J. Foster Crowell read some notes of a Visit to the Line of the Panama Canal.

The Tellers announced the following elections: Members: Rawlinson T. Bayliss, Marysville, Mont.; Harry W. Edwards, West Superior, Wis.; John E. Greiner, Baltimore, Md.; Carl R. Grimm, Trenton, N. J.; John B. Henderson, Brisbane, Queensland, Australia; Karl E. Hilgard, Cincinnati, O.; Gilbert Hodges, Boston, Mass.; Charles C. Hopkins, Gloversville, N. Y.; Andrew L. Johnston, Richmond, Va.; Claude W. Kinder, Tientsin, China; William McK. Marple, Scranton, Pa.; Charles E. Marvin, Macon, Ga.; Mitsugu Sengoku, Tokyo, Japan; Reuben Skirreffs, Paterson, N. J.; Charles W. Walton, Detroit, Mich.; Ethelbert G. Woodford, Pretoria, Transvaal Republic.

Juniors: Wainwright Parrish, Albany, N. Y.; George E. Roehm, Detroit, Mich.; William L. Sisson, Baltimore, Md.; Charles H. Smith, Middletown, N. Y.

The annual convention was to be held at Cresson, Pa., beginning June 26. The programme included one business session, several sessions for reading and discussion of papers, the annual address by President Shinn and the yearly dinner. A number of important papers were presented at the convention.

New England Water-Works Association.—The Annual Convention began in Portland, Me., June 11. President Brackett delivered an address showing the progress of the Association and the work accomplished. The Secretary reported that there are now 335 members.

The Committee on Classification of Water Rates presented a report showing that there was a very wide difference, and coming to no final conclusion. The Committee was continued for another year.

A number of new members were elected.

A paper on Public and Private Ownership of Water Works, by C. W. Morse, was read and discussed.

On the second day papers on Analysis of Water, on Cement

Pipe and on Water-Works in Holland were read, and Mr. A. Feley gave a description of the new Croton Aqueduct in New York illustrated by lantern views. There were also discussions on a number of questions suggested by members.

At an evening session papers on Recording Gauges; on Water Meters and on Ground Water-Supply were read and discussed, and the topical discussions continued.

The third day was devoted to a visit to the Portland Water Works at Lake Sebago, 17 miles from the city, which were carefully examined by members. The annual banquet of the Association was held on the evening of the first day of the Convention.

Boston Society of Civil Engineers.—At the regular meeting, May 21, Professor Thomas M. Drown, Professor William T. Sedgwick and Mr. George F. Chace were elected members.

The Committee on Affiliation with the American Society of Civil Engineers made a report, recommending a plan providing for interchange of papers, joint publication and general mutual exchange of privileges of members, without surrender of separate organizations.

Mr. S. L. Minot read a paper on Improved Railroad Terminal Facilities for Providence, giving the history of the various plans offered for improving the station accommodations in that city, and describing the plan finally adopted, which was prepared by Mr. Minot and Mr. E. P. Dawley, Chief Engineer of the New York, Providence & Boston Railroad.

Mr. L. B. Bidwell read a paper describing the Asylum Street Improvement in Hartford, Conn., and the new station in that city.

Engineers' Club of Philadelphia.—At the regular meeting, May 17, Professor J. W. Redway read a paper on the Physical Geography of the Mississippi River.

The Secretary presented, for Mr. George W. Creighton, a paper on Rail Joints.

The meeting concluded with a lunch, arrangements having been made to provide one at each regular meeting.

At the regular meeting, June 7, resolutions were passed offering the use of the Club rooms on an occasion of the reception of the British Iron & Steel Association.

The Secretary presented for Mr. Strickland L. Kneass a description of the new condensed and refrigerating system.

Engineers' Society of Western Pennsylvania.—At the regular meeting in Pittsburgh, May 20, the Committee on Relations with American Society of Civil Engineers—W. L. Scaife, Thomas P. Roberts and John W. Langley—reported in favor of a federation of the other engineering associations with the American Society for certain purposes of general concern, each association to preserve its individuality. The report was approved, and the scheme as suggested will be submitted to the American Society.

Mr. M. J. Becker read a paper describing the work of building the bridge over the Ohio River at Steubenville, O., for the Pittsburgh, Cincinnati & St. Louis Railroad.

Engineers' Club of Cincinnati.—At the regular May meeting of the Club Messrs. W. H. D. Totten, Jr., Alfred Koechlin, G. P. Walker, and John C. Lemon were elected members.

An agreeable diversion from the regular programme of reading a paper on some engineering subject was observed, and in its stead the members and their lady friends and some invited guests listened to a very interesting lecture by Colonel William E. Merrill, U. S. Engineers, on a Hasty Trip to the Paris Exposition.

The lecture was illustrated with some 90 lantern pictures prepared from photographs secured by Colonel Merrill while on a visit to Europe in the fall of 1889 with the American engineers who made the tour of Europe.

The lecture comprised a description of the Forth Bridge and the Eiffel Tower, and a short historic sketch of many places of interest and renown in European countries.

Civil Engineers' Club of Cleveland.—At the regular meeting, June 10, Mr. Albert H. Porter was elected Secretary. Messrs. Edward P. Roberts, William H. Dunn, James Hallstead, John H. Hilton and William F. Biggar were elected members; Joseph Daniels, Thomas M. Irvine and William Otis, associate members.

A committee of five was appointed to make arrangements for the annual picnic to be held at Rocky River in the latter part

of July. The receipt of several books, pamphlets and photographs was announced.

Dr. Herman Poole read a paper on Ferroid, which is a new artificial stone, and the paper was discussed.

Professor Charles S. Howe read a paper on the Almucanter, a new instrument for field astronomy, which greatly simplifies observations and calculations for time and latitude. This was illustrated by a large drawing prepared by Professor Saunders, and called out a long discussion.

Engineering Association of the Southwest.—At the regular meeting in Nashville, Tenn., June 12, several communications were read and referred to proper committees. Mr. W. C. Smith presented the Association with a group of framed views of the Forth Bridge and the Eiffel Tower.

The Committee on the Cause of Setting of Cement requested more time, in consequence of the illness of members of the Committee. The Committee on Affiliation with the American Society reported that it had been impossible for any member to attend the meeting in New York, June 4, and asked to be discharged. There was a short discussion on this subject.

Mr. John B. Atkinson read a paper on Coke Making in the Western Kentucky Coal Field, which described a series of experiments carried on at Earlinton, Ky., for the purpose of desulphurizing coke. These experiments are not yet completed, but are of great importance, for should they be successful there will be a largely increased demand for Kentucky coal, which is at present unsuited to iron making.

Western Society of Engineers.—At the regular meeting in Chicago, May 7, a communication relating to affiliation with the American Society of Civil Engineers was referred to a special committee.

The subject for discussion was the reports presented on the Railroad Problem in Chicago. These reports were thoroughly discussed by members present. Figures were presented for the cost of elevated railroads, and a new plan was described for a four-track steel viaduct on brick piers.

Engineers' Club of St. Louis.—At the regular meeting, May 21, it was announced that the purse to be presented to the son of the late Professor Smith, for many years Secretary of the Club, had reached the amount of \$270.

A paper by George A. Brown on the Function of the Government in a Plan for General Irrigation was read. The paper discussed the necessity for a general system of law to govern irrigation and water rights and argued in favor of a Government title to water privileges. Incidentally it discussed rainfall in general and as affected by forests.

The paper was discussed by Messrs. Blaisdell, Curtis, Johnson, Moore, Nipher and others. Professor Nipher said that experiments extending over a long period of years had demonstrated that the apparent increase in rainfall in forests was due to the fact that the rain caught in the gauges was not affected by wind currents. Improved forms of rain-gauges had shown that there was no actual difference between the amount of rain falling in forests and in open places.

At the regular meeting, June 4, J. G. Jennings was elected a member.

Colonel Meier, President of the Committee on Eads Monument, announced the formation of the Eads Monument Association, and suggested the advisability of members of the Club joining that association.

Mr. Russell, Chairman of the Committee on Local Data, then presented his report. The nature of the matter collected was explained, and the ground covered and the names of the contributors were given. Some informal discussion of the matter presented took place. It was ordered that the committee be continued, with authority to employ expert assistance, if necessary, to edit the report, and to secure for the Club estimates on the cost of publication.

Professor Nipher called attention to the fact that rainfall in the State of Missouri was almost exactly equivalent to the river discharge at St. Louis.

Engineers' Club of Kansas City.—At the regular meeting, May 12, Mr. A. Clifford Thomson was elected a member.

The Committee on Affiliation of Engineering Societies presented a brief report adverse to a connection with the American Society of Civil Engineers; also several communications. After a short discussion the report was accepted and the Committee continued.

The Secretary read a paper by Mr. Robert M. Sheridan on

the Evolution of the Elevator, tracing the growth of the elevator engine up to its present stage of development.

Denver Society of Civil Engineers.—At the regular meeting, May 28, Mr. W. W. Follett read a paper on Dams and Reservoirs, treating both of methods of construction of dams and of the best locations for reservoirs. The paper was written with special reference to the storage of water for irrigation purposes.

The reading was followed by a general discussion of the subject by members present.

Technical Society of the Pacific Coast.—At the regular meeting in San Francisco, May 2, Mr. P. M. Randall read a paper on the Pohle Pumping System, giving a mathematical analysis from formulae of his own construction.

NOTES AND NEWS.

Russian Torpedo-Boats.—The Imperial Russian Government has just received three new torpedo-boats from Mr. Schichau, of Elbing. One of these is described as follows in *Engineering*:

"The torpedo dispatch boat *Adler* belongs to a new type introduced by Mr. Schichau, and is similar in principle to the boats built for the Italian Navy, *Aquila*, *Nibbio*, *Falko*, *Avoltoio*, *Sparviero*. She is a twin-screw boat of 46.5 meters (152 ft. 7 in.) length and 5.2 meters (17 ft.) breadth, and displacement about 150 tons. She is fitted with two locomotive boilers and twin engines of about 2,300 indicated horse-power collective. The speed guaranteed was 26.5 knots per hour during a two hours' continuous run, and in many well-informed circles the accomplishment of this feat was looked at as impossible. The mean speed of the *Adler* during two hours was 26.55 knots per hour. The Russian Government possesses in this steamer one of the fastest vessels in the world. All three ships will shortly be taken out by Russian officers and crews round Europe to the Black Sea."

Growth of Trades Unions in England.—A correspondent of the *Engineer* says: "In connection with the various Trades Unions' Organizations, the enormous growth of membership which has been going on during the past year is a matter which deserves serious consideration, as although the societies naturally congratulate themselves upon this apparent addition of strength to their ranks, it is not improbable that in the event of any serious slackening off in trade this largely increased membership may become a source of weakness. With the object of swelling their numbers, some of the societies have not been very particular as to the class of men they have admitted, and the result may be, that directly there is a decreasing activity in the workshops, large numbers of these men may be thrown upon the books of the societies for out-of-work support. The Amalgamated Society of Engineers has been making more progress than any other society in increasing its membership, and during the past month there has been a further addition of something like 700 members. The same thing is going on in smaller societies, the United Machine Workers' Association, whose annual report has just been issued to the members, having during the past couple of years more than doubled the number of its members, and during four years the society has increased from a membership of 370, with nine branches, up to a membership of over 2000, with twenty-eight branches. With regard to the funds of the associations, it may be interesting to notice that the Steam Engine Makers' Society is now for the first time able to report a larger accumulation of funds in proportion to membership than the Amalgamated Society of Engineers, the declared value of the Steam Engine Makers' Society being now £3 10s. 4½d., and of the Amalgamated Society of Engineers £3 9s. 1d. per member. The Amalgamated Engineers' Society at one time was able to declare a value of £6 3s. 5d., and the Steam Engine Makers of £4 1s. 4d. per member, so that both of the societies have still a great deal to do in the accumulation of funds to place them in the same satisfactory position that the organizations occupied only a few years ago."

The Eiffel Tower as a Lightning Rod.—In an English paper it is said that a thunderstorm of exceptional violence has passed over Paris, and the Eiffel Tower has borne the brunt of a severe thunderbolt experience. The gigantic structure has stood the test magnificently, and when scientific men have put their heads together and summed up the results of the storm, we can hardly doubt that the conclusion must be in favor of the tower as a huge lightning-rod which relieves the rest of Paris of dangers and presents no probable danger from elemental strife

in itself. During the exhibition there were various storms through which the tower passed scathless, like an iron ship at sea. But during the heavy discharge of atmospheric artillery on Saturday, May 10, 1890, the tower was struck six times, and thus the test of its electric conductivity was excellent. Not the slightest damage resulted either to the structure or to any person occupied on its various stages. The lightning was distinctly seen to zigzag toward the summit and to track its way down the column. Vibration of some kind was experienced, but whether from the discharge of electricity, or from the loud peals overhead, is perhaps a moot point. We are inclined to think that a recent discussion on the utility of lightning-rods may be drawn to a conclusion by this experience of the Eiffel Tower, and that the promoters of the great tower in London, which is to be not less than 1,200 ft. in height, may proceed courageously with their work, possessed with the assurance that if the structure accepted be not beautiful, it may at least be useful.

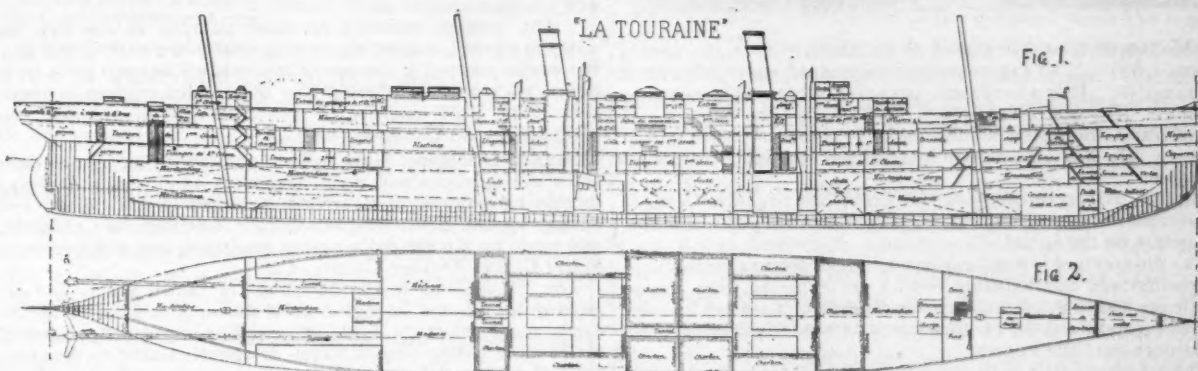
Colors of British Locomotives.—The locomotives on the Glasgow & Southwestern Railway are painted black; those on the London & Southwestern, light green, approaching a pea green; on the Caledonian and the Great Eastern, dark blue; on the North British and the London, Brighton & South Coast, yellow ochre.

Magazine Rifles for the Indian Army.—It is anticipated that the whole of the British infantry garrison in India will be armed with the new rifle before the close of the year. Eight

general interest to see whether the men, having obtained what they wanted in the way of the extra hour on Saturday, would honorably fulfil their part of the agreement and come to work on Tuesday morning, notwithstanding old habits and many temptations to prolong their holiday. As far as can be at present ascertained, the only works where the men acted fairly up to the spirit of the agreement were those at Elswick. At almost all others the attendance was either so poor that it was not worth while to keep the machinery going, or the men, after putting in an appearance, went away and did not return for the rest of the day. It appears almost impossible to get average workmen to keep agreements or honorable understandings, whatever their representatives may undertake in their behalf, and employers have just to put up with the loss and damage sustained thereby as best they can. It would seem that the Elswick men are decidedly superior to the average in this respect."

A failure to keep such agreements is the most serious obstacle in the way of carrying out amicable agreements with workmen or their representatives. Those who fail to act up to the spirit of such honorable understandings are the greatest enemies to the true interests of the men, as they make amicable agreements between their employers and themselves useless and such relations as should exist between honorable men impossible.

A New French Steamer.—The latest steamer of the Compagnie Generale Transatlantique—*La Touraine*—was recently



thousand magazine rifles should have reached India by now, and another six thousand are being dispatched this month.

Export of Scotch Locomotives.—During the first three months of this year there were exported from Scotland locomotives of a total value of £90,469, against a quarterly average of £90,000 last year, and of £71,000 in 1888. The value of those shipped during the first quarter of this year to the Continent was £50,000, and those to Australasia £14,000.

Flameless Combustion.—In a recent lecture on "Flameless Combustion," Mr. T. Fletcher said: "The appearance of flame is misleading, and the greater the flame the smaller the work done, other things being equal. I have been asked by a well-known engineer if I could explain why certain boilers gave such an exceedingly small duty for the fuel consumed when the flues were, as he said, 'filled from end to end with magnificent flame.' The fact was that his so-called magnificent flame was a delusion, hollow and cold inside, and not coming in contact with his boiler at all. When the same fuel was burned with a very small flame, hardly visible over the bridge, the duty increased some 30 per cent."

A Point of Honor not Sustained.—The *Engineer's* commercial correspondent from the North of England writes to that paper: "It will be remembered that when the engineering employers on the Tyne and Wear conceded a short time since to their workmen the right of leaving work at twelve instead of one o'clock on Saturdays, it was agreed on behalf of the men that there should in the future be less time lost in and after general holidays. The latter were more clearly specified than before. Among others they were to include Whit Monday, but not Whit Tuesday. One paragraph in the agreement ran as follows: 'That any man or men not returning to work at the proper time after the holidays may be suspended or dismissed without notice, it being understood that the men suspended or dismissed shall not receive any benefit from their Society until they have worked a month, according to their Society's rules. The men's delegates promise, on their part, to represent to the men that it is a point of honor to act up to the spirit of this agreement.' Inasmuch as last Monday was the first occasion on which the new arrangement came into force, it was a matter of great and

launched at Havre. This ship is 516½ ft. long between perpendiculars, 56 ft. beam, and draws 23.6 ft. of water. She will have accommodations for 392 first-class, 114 second-class, and 540 steerage passengers—1,046 in all—and all the cabin arrangements are of the latest and most approved types.

The ship will have two three-bladed screws, 19.7 ft. in diameter. Each screw is driven by a separate triple-expansion engine, of the vertical type, with cylinders 41 in., 60½ in. and 100 in. in diameter by 65½ in. stroke. The crank shafts and screw shafts are of steel, forged at the Creusot Works, and are hollow, the external diameter being 20.3 in. and the internal 6.3 in.

There are 12 boilers, 14 ft. 9 in. in diameter and 20 ft. 4 in. long. Nine of them are double, each with six corrugated cylindrical fire-boxes, three at each end, and the other three are single, with three fire-boxes each. They are provided with forced draft on the Audenet system.

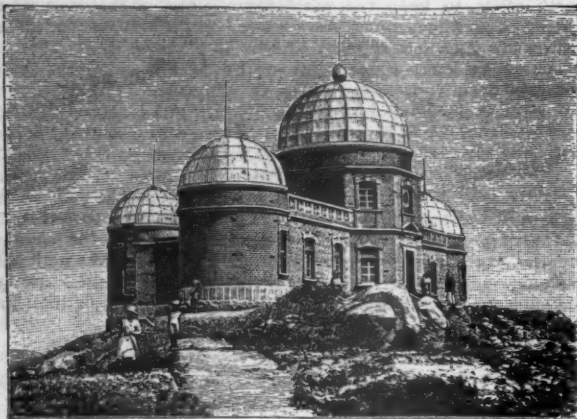
La Touraine is expected to reach a speed of 19½ knots an hour on trial, or about 18½ knots in actual service. She is intended for the line between Havre and New York. The ship and engines were designed by M. Daynard, Chief Engineer of the Company, and built at St. Nazaire. In the accompanying illustrations—from *Le Genie Civil*—fig. 1 is a sketch showing a longitudinal section of the ship; fig. 2 a sketch plan of the lower deck, showing the positions of the engines, boilers, and screws.

Metal Taper Tubes for Telegraph Poles.—The trades correspondent of the *Engineer*, writing of the Birmingham, Wolverhampton and other districts, says that there is a heavy output at date of metal taper tubes for telegraph poles and also of wrought-iron flange pipes for South Africa for the conveyance of water.

The Fastest Cruiser.—At the yards of Armstrong & Company in Elswick, England, there was recently launched the armored cruiser *Necochea*, for the Argentine Republic, which is expected to be the fastest warship afloat. This vessel is 300 ft. long, 43 ft. beam and 3,200 tons displacement; she will carry two 21-cm. (8.27-in.) breech-loading rifles, eight 12-cm. (4.72-in.) rapid-fire guns and 24 smaller rapid-fire and machine guns, besides torpedo tubes.

The engines of the *Necochea* are expected to develop 13,500 H.P., and to propel the ship at a speed of 22 knots—nearly 26 miles—an hour, and it is hoped that this may be slightly exceeded on trial.

An African Observatory.—A remarkable scientific establishment has just been completed by M. Colin, which is the only observatory on the east coast of Africa. It is on the island



of Madagascar, and is placed at an altitude of 1,400 meters (about 4,600 ft.), on the summit of a mountain a few miles from Tananarivo. It is a handsome structure of cut stone, with four cupolas. The cost was met by contributions from persons and associations interested in developing French influence in that country. It has also the support of the French Academy of Sciences.

Besides astronomical work, M. Colin has organized a regular service for meteorological observations with posts at different points on the island.

The observatory is well supplied with instruments, including a magnetograph, and valuable results are expected, both astronomically and in information concerning the climate and meteorological conditions of Madagascar and the neighboring seas, heretofore but little known.

The accompanying illustration is from a photograph, attached to a paper prepared by M. Mascart for the Academy of Sciences.—*Le Génie Civil*.

Forced Draft.—The British Admiralty appear to be coming round to the view that most naval officers took some time ago, that forced draft is a mistake, and they are disposed to substitute for it an improved natural draft. Manufacturers of engines say that four hours' steaming under forced draft takes about four years' wear out of a ship's boilers. Engineers in the British Navy are not allowed to use the forced draft except in vessels fitted with locomotive boilers.

Coal Mining in Japan.—The correspondence of the *Economiste Française* says that the total production of coal in Japan in 1889 was 6,105,126 tons, an increase of 39.2 per cent. over the previous year. The most important producing point is the Miike Mine in Foukonoka, from which 1,106,772 tons were taken last year; the next is the Karatsou Mine in Saga, from which 262,237 tons were taken.

Coal is produced in 13 departments, and is of varying quality. The production last year is valued at \$14,461,070, an average of \$2.37 per ton.

The Bay City Water Works.—The report of Mr. E. L. Dunbar, Superintendent of the Water Works of Bay City, Mich., shows that the plant of these works includes one Gaskill horizontal, compound, condensing, crank and fly-wheel pumping-engine, having a maximum capacity of 5,000,000 galls. in 24 hours, or 121 galls. per revolution; one Holly quadruplex, compound, condensing, crank and fly-wheel pumping-engine, having a maximum capacity of 3,000,000 galls. in 24 hours, or 55 galls. per revolution; one horizontal, high-pressure, piston engine driving through gearing two No. 10 Holly rotary pumps, having a maximum capacity of 2,500,000 galls. in 24 hours, or 17 galls. per revolution. The fuel used is pine slabs and edgings, of which 2,338 cords were used during the year, the average cost, including the labor of delivering from the wood-yard to the fire-room, being 71.3 cents per cord. The net cost of running the pumping-engines for the year was \$5,721, being an average of \$6.06 per million gallons pumped, or \$5.49 per million gallons raised 100 ft. The detailed statement of performance is as follows:

"The Gaskill engines have been run during the year 8,659

hours and 27 minutes, having been shut down 100 hours and 33 minutes for repairs, packing, etc. The longest continuous run of these engines was 36 days, from August 20 to September 25.

"The Holly quadruplex engines have been run 123 hours and 53 minutes, 24 hours and 5 minutes of which was with the Gaskill engines in operation, and 99 hours and 48 minutes pumping the entire city supply.

"The high-pressure engine and rotary pumps have been run 45 minutes, during which time they pumped the supply of the city.

"Total quantity of water pumped:

By Gaskill engines	929,305,047 galls.
By quadruplex engines.....	15,055,755 "
By rotary pumps.....	111,945 "
Total.....	944,472,747 galls.

"Of this 932,866,053 galls. were pumped against an average domestic pressure of 40 lbs. per square inch at the pressure gauge in the pumping station, which is equivalent to a lift of 108 ft. from the level of the water in the wells; and 11,606,694 galls. were pumped against an average pressure of 85.16 lbs. at the gauge, equivalent to a lift of 217 ft. from the surface level of the water. The average lift of all the water pumped was 110.4 ft.

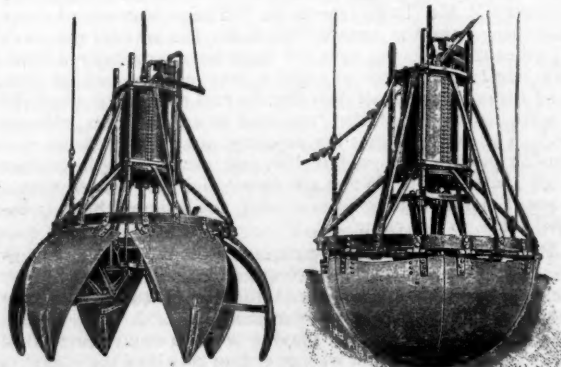
"The number of fire alarms received at the pumping station was 99, and the works were run under fire pressure 63 hours and 48 minutes.

"The greatest quantity of water pumped in one day was 4,067,855 galls., August 19; during nearly one hour of this day, the works pumped at the rate of more than 8,000,000 galls. in 24 hours, with only the Gaskill and quadruplex engines in operation. The least quantity of water pumped in one day was 2,187,922 galls., November 28."

Steam Dredging Gear.—The accompanying illustrations show an ingenious and novel apparatus employed in dredging or moving material in earth cuts, patented in this country and abroad by Mr. S. N. Knight and J. P. Lambing, of California, and made by Knight & Company, engineers and millwrights at Sutter Creek, Amador County, Cal.

The "grab," as it may be called, is shown empty and expanded in fig. 1. In fig. 2, it is shown closed buried in the earth, and filled ready for hoisting. The apparatus consists of six or more strong hinged leaves or shovels linked to the cross head of a powerful steam piston seen on top, so the leaves are forced into material that could not be worked with the common clam-shell dredge buckets. The engraving is taken from the grabs forming a part of the plant at the Arroyo Seco Mine near Lone, in Amador County, where the workings are as peculiar as they are extensive. They consist of deep open cutting in the bed of a stream, and the operations are not different from deep cuts made for railways or other work. The grab is 6 ft. in diameter and 11 ft. high over all, and although made of wrought iron and steel throughout, weighs 3,700 lbs. when ar-

FIG. 1 FIG. 2



ranged for gravel and hard working, and lifts 2½ tons at a load. The steam cylinder is of wrought iron 22 in. in diameter, with a stroke of 30 in., and will exert a pull of more than 30,000 lbs., which, with the gravity of the machine, gives a penetrating force of more than 16 tons, enough to penetrate material of almost any kind except solid rock.

The boom on which the grab is swung is 110 ft. long, swings through 180°, and delivers a load in 1½ to 2 minutes' time, from 20 to 30 ft. high. In one modification proposed by Knight & Company, the boom swings through a complete circle, and consequently can load cars behind, when making a cut. In working under water the grab cylinders can be operated by air instead of steam.—*Industry, San Francisco*.